



This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

- + *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.
- + *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.
- + *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.
- + *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at <http://books.google.com/>

Sci 1590.7



HARVARD
COLLEGE
LIBRARY

THE
JOURNAL
OF THE
ROYAL AGRICULTURAL SOCIETY
OF ENGLAND.

VOLUME THE TWENTY-FOURTH.

PRACTICE WITH SCIENCE.

LONDON:
JOHN MURRAY, ALBEMARLE STREET.

1863.

Sci 15^A 90.7
✓

HARVARD COLLEGE LIBRARY
TRANSFERRED FROM
BUSSEY INSTITUTION
1936

THESE EXPERIMENTS, IT IS TRUE, ARE NOT EASY; STILL THEY ARE IN THE POWER OF EVERY THINKING HUSBANDMAN. HE WHO ACCOMPLISHES BUT ONE, OF HOWEVER LIMITED APPLICATION, AND TAKES CARE TO REPORT IT FAITHFULLY, ADVANCES THE SCIENCE, AND, CONSEQUENTLY, THE PRACTICE OF AGRICULTURE, AND ACQUIRES THEREBY A RIGHT TO THE GRATITUDE OF HIS FELLOWS, AND OF THOSE WHO COME AFTER. TO MAKE MANY SUCH IS BEYOND THE POWER OF MOST INDIVIDUALS, AND CANNOT BE EXPECTED. THE FIRST CARE OF ALL SOCIETIES FORMED FOR THE IMPROVEMENT OF OUR SCIENCE SHOULD BE TO PREPARE THE FORMS OF SUCH EXPERIMENTS, AND TO DISTRIBUTE THE EXECUTION OF THESE AMONG THEIR MEMBERS.

VON THARE, *Principles of Agriculture*.

LONDON: PRINTED BY WILLIAM CLOWES AND SONS, DUKE STREET, STAMFORD STREET,
AND CHANCING CROSS.

CONTENTS OF VOL. XXIV.

STATISTICS :—

	PAGE
Meteorology, for the six months ending December 31, 1862 ..	II
Public Health ditto ditto	VI
Price of Provisions ditto ditto	VI
Weekly Average Price of Wheat	VIII
Meteorology, for the six months ending June 30, 1863	X
Public Health ditto ditto	XIV
Price of Provisions ditto ditto	XV

ARTICLE

	PAGE
I.—Land Valuing. By Philip D. Tuckett, F.G.S., Prize Essay ..	1
II.—The Prize Farms of France. By P. H. Frere	8
III.—Absorption of Soluble Phosphate of Lime by different Soils of known composition; and Remarks on the Application of Superphosphate and other Phosphatic Manures to Root-crops. By Dr. Augustus Voelcker	37
IV.—Utilisation of Town Sewage. By J. B. Lawes, F.R.S., F.C.S.	65
V.—Supply of Horses Adapted to the Requirements of the English Army; with Notes on the Remount System in the French Army. By J. Wilkinson	91
VI.—Experiments with different Top-Dressings upon Wheat. By Dr. Augustus Voelcker	100
VII.—Earth <i>versus</i> Water for the Removal and Utilisation of Excrementitious Matter. By the Rev. Henry Moule	111
VIII.—The Money-Value of Night-Soil and other Manures. By P. H. Frere	124
IX.—Effects of different Manures on the Mixed Herbage of Grass-land. By J. B. Lawes, F.R.S., F.C.S., and J. H. Gilbert, Ph.D., F.R.S., F.C.S.	131
X.—Co-operative Farms at Assington, Suffolk	165
XI.—Review of 'Italian Irrigation, by R. Baird Smith, Captain of Engineers, Bengal Presidency, F.G.S.' By P. H. Frere ..	173
XII.—Statistics of Live-Stock for Consumption in the Metropolis. By Robert Herbert	206
XIII.—Some Account of Brittany Cows. Taken from Notices by M. Jamet, of Rennes. By P. H. Frere	213
XIV.—Cultivation of Carrots and Cabbages for the Feeding of Stock. By C. Lawrence	216
XV.—Experiments on Transplanting Mangold. By W. Gurdon ..	221
XVI.—Growth of Barley after a Grass-layer. By P. H. Frere ..	225

ARTICLE	PAGE
XVII.—Breeding of Horses—a Letter addressed to the Right Hon. John Evelyn Denison. By W. Dickenson	255
XXVIII.—Reclaiming of Waste Lands as instanced in Wichwood Forest. By C. Belcher. Prize Essay	271
XIX.—Milk. By Dr. Augustus Voelcker	286
XX.—Results of Steam Cultivation. By W. T. Moscrop. Prize Essay	320
XXI.—Breeding of Hunters and Roadsters. By J. Gamgee, Senior. Prize Essay	336
XXII.—Five Years' Progress of Steam Cultivation. By John Algernon Clarke	362
XXIII.—Development and Action of the Roots of Agricultural Plants at various stages of their Growth. By the Rev. M. J. Berkeley, M.A., F.L.S.	419
XXIV.—M. J. Reiset's Agricultural Experiments. By P. H. Frere ..	436
XXV.—Statistics of Live-Stock and Dead Meat for Consumption in the Metropolis. By Robert Herbert	454
XXVI.—Report of the Stewards of Stock at the Worcester Show ..	459
XXVII.—Judges' Report on Steam Cultivators at Worcester	480
XXVIII.—Report on the Worcester Show-yard	487
XXIX.—Further Report of Experiments with different Manures on Permanent Meadow Land. By J. B. Lawes, F.R.S., F.C.S., and J. H. Gilbert, Ph.D., F.R.S., F.C.S.	504

MISCELLANEOUS COMMUNICATIONS AND NOTICES:

1. Burning of Clay Land. By C. Randell	540
2. Portable Fencing. By T. Bowick	544
3. Composition of Annatto. By Professor Voelcker	549
4. Cheap Material for Farm Buildings. By J. F. Clarke	552
5. Dairy Practice. By E. Harding	553
6. Homoeopathic Treatment of Cattle. By P. H. Frere	554

ABSTRACT REPORT OF AGRICULTURAL DISCUSSIONS:—

Splenic Apoplexy. By Professor Simonds	228
Materials for Construction of Cottages. By J. Taylor	559
Effect of Under-drainage on Rivers, &c. By Bailey Denton ..	573
Adulteration of Oilcakes. By Professor Voelcker	589
Internal Parasites. By Professor Simonds	597
Steam Cultivation. By E. Ruck	610
Breeding and Feeding of Sheep. By Professor Coleman	623
Effect of Manures on Grass Lands. By Professor Voelcker	639

Agricultural Patents for 1862	653
-------------------------------------	-----

CONTENTS.

APPENDIX.

	PAGE
List of Officers of the Royal Agricultural Society of England, 1863-64	i, xxxi
Standing Committees for 1863-64	iii, xxxiii
Memoranda of Meetings, Payment of Subscription, &c.	v, xxxv
Report of the Council to the General Meeting, December 11, 1862 ..	vi
London Show Account	ix
Cash Account and Balance-sheets, ending December 31, 1862 ..	x—xiii
Schedule of Prizes : Worcester Meeting, 1863	xiv
Distribution of Prizes in Heifer Classes, Battersea Show	xxiv
Prizes for Essays, and Rules of Competition	xxv, lxx
Members' Chemical Analysis and Veterinary Privileges	xxix, lxxiii
Report of the Council to the General Meeting, May 22, 1863	xxxvi
Cash Account and Balance-sheets, ending June 30, 1863	xxxviii—xl
List of Stewards, Judges, &c., at the Worcester Meeting	xli
Prize-Awards of the Judges of Live-Stock : Worcester Meeting	xlii
Special Prizes offered by the Worcester Local Committee	lxi
Prize-Awards of the Judges of Implements : Worcester Meeting	lxvi

DIRECTIONS TO THE BINDER.

The Binder is desired to collect together all the Appendix matter, with Roman numeral folios, and place it at the end of each volume of the Journal, excepting Titles and Contents, and Statistics &c., which are in all cases to be placed at the beginning of the Volume: the lettering at the back to include a statement of the year as well as the volume; the first volume belonging to 1839-40, the second to 1841; the third to 1842, the fourth to 1843, and so on.

In Reprints of the Journal all Appendix matter (and in one instance an Article in the body of the Journal), which at the time had become obsolete, were omitted; the Roman numeral folios, however (for convenience of reference), being reprinted without alteration in the Appendix matter retained.

STATISTICS
OF
THE WEATHER, PUBLIC HEALTH, PRICE OF
PROVISIONS, &c., &c.,
FOR THE SIX MONTHS ENDING DECEMBER 31, 1862.

*Chiefly extracted from the Quarterly Report of the Registrar-General.—
The Corn Returns and Diagram are prepared from Official Documents
expressly for this Journal.*

ON

THE METEOROLOGY OF ENGLAND

DURING

THE QUARTER ENDING SEPTEMBER 30, 1862.

BY JAMES GLAISHER, Esq., F.R.S.,

SEC. OF THE BRITISH METEOROLOGICAL SOCIETY.

THE cold weather which set in on the 9th of June continued with trifling exceptions till the 12th of September; the average daily deficiency of temperature during these 96 days was $2\frac{1}{2}^{\circ}$. From the 13th to the 30th of September the weather was warm, the average daily excess being $2\frac{1}{2}^{\circ}$.

The mean high day temperature of the air was $2^{\circ}9$ in defect in July, $1^{\circ}9$ in defect in August, and $0^{\circ}1$ in excess in September, as compared with the averages of the preceding 21 years.

The mean low night temperature of the air was $2^{\circ}4$ in defect in July, $2^{\circ}0$ in defect in August, and $1^{\circ}2$ in excess in September.

The mean temperature of the air was $2^{\circ}7$ in defect in July, $1^{\circ}9$ in defect in August, and $0^{\circ}8$ in excess in September.

The mean temperature of the dew-point was $1^{\circ}5$ in defect in July, $0^{\circ}6$ in defect in August, and $1^{\circ}4$ in excess in September. The degree of humidity was at all times above its average value.

The pressure of the atmosphere in each month was very nearly of its average value.

The fall of rain in July was 1.7 inch, in August 3.0 inches, and in September 1.6 inch; the total fall for the quarter was 6.3 inches, being 1.2 inch below the average of the preceding 43 years.

The temperature of vegetation as shown by a thermometer placed on grass was between 30° and 40° on 9 nights, and above 40° on the other 83 nights.

The mean temperature of the air at Greenwich in the three months ending August, constituting the three summer months, was $53^{\circ}9$, being $0^{\circ}4$ below the average of the preceding 91 years.

THE WEATHER DURING THE QUARTER ENDING SEPTEMBER 30, 1862.

Temperature of												
1862. MONTHS.	Air.		Evaporation.		Dew Point.		Air—Daily Range.		Elastic Force of Vapour.	Weight of Vapour in a Cubic Foot of Air.		
	Mean.	Diff. from average of 21 years.	Diff. from average of 21 years.	Mean.	Diff. from average of 21 years.	Mean.	Diff. from average of 21 years.	Mean.			Diff. from average of 21 years.	
July	59.2	-2.3	55.6	-1.9	52.4	-1.5	20.0	-0.5	in.	grs.		
August ..	59.5	-1.1	56.3	-1.3	53.5	-0.6	19.5	+0.1	.394	4.5		
September..	57.7	+1.4	55.0	+1.1	52.5	+1.4	17.5	-1.1	.410	4.6		
Mean ..	58.7	-0.7	55.6	-0.7	52.8	-0.2	19.0	-0.5	.396	4.4		
									.400	4.5		
										0.0		
1862. MONTHS.	Degree of Humidity.		Reading of Barometer.		Weight of a Cubic Foot of Air.		Rain.		Temperature of Water of the Thames.		Reading of Thermometer on Gram.	
	Mean.	Diff. from average of 21 years.	Mean.	Diff. from average of 21 years.	Mean.	Diff. from average of 21 years.	Amount.	Diff. from average of 43 years.	At or below 30°.	Between 30° and 40°.	Above 40°.	Highest Reading at Night.
July	78	+2	29.762	in.	grs.	in.	1.7	in.	0	2	29	37.5
August ..	81	+4	29.785	-0.033	531	+3	3.0	-1.0	0	1	30	39.7
September..	83	+2	29.859	-0.006	530	+2	1.6	+0.6	0	6	24	32.0
Mean ..	81	+3	29.802	+0.036	534	Sum	6.3	Sum	Sum	Sum	Sum	Highest
				-0.001	532	+3		-1.2	0	9	83	32.0
												56.1
												55.0
												56.1

NOTE.—In reading this table it will be borne in mind that the sign (-) minus signifies below the average, and that the sign (+) plus signifies above the average.

(IV)

ON

THE METEOROLOGY OF ENGLAND

DURING

THE QUARTER ENDING DECEMBER 31, 1862.

By JAMES GLAISHER, Esq., F.R.S.,

SEC. OF THE BRITISH METEOROLOGICAL SOCIETY.

From the beginning of the quarter to the 17th the weather was warm, the excess of temperature amounting to $4\frac{1}{2}^{\circ}$ daily; and to $3\frac{1}{2}^{\circ}$ for the 35 days ending October 17th. On the 8th a variable period set in and continued to the 30th, the average deficiency being $1\frac{1}{2}^{\circ}$ daily. After a week of warm weather a cold period set in on November 6th and continued to December 2nd, with a deficiency of $4\frac{1}{2}^{\circ}$ daily; from December 3rd to 31st there was an excess of $4\frac{1}{2}^{\circ}$ daily.

The mean high day temperature was $1^{\circ}9$ in excess in October, $3^{\circ}4$ in defect in November, and $3^{\circ}0$ in excess in December.

The mean low night temperature was $1^{\circ}7$ in excess in October, $3^{\circ}2$ in defect in November, and $3^{\circ}1$ in excess in December.

The mean temperature of the air was $1^{\circ}4$ in excess in October, $4^{\circ}4$ in defect in November, and $3^{\circ}5$ in excess in December.

The mean temperature of the dew-point was $2^{\circ}4$ in excess in October, $2^{\circ}6$ in defect in November, and $3^{\circ}4$ in excess in December; the degree of humidity being above its average in October and November, and below in December.

The pressure of the atmosphere was 0.03 inch in excess in October, and 0.05 inch in November and December.

The fall of rain was 4.0 inches in October, 1.0 inch in November, and 1.6 inch in December. The total fall for the quarter was 6.6 inches, being $\frac{1}{2}$ an inch above the average of the preceding 43 years. The total fall of rain for the year is 26.2 inches, being 1.2 inch above the average.

The temperature of vegetation was below 30° on 26 nights; between 30° and 40° on 36 nights; and above 40° on 30 nights.

The mean temperature of the air at Greenwich in the three months ending November, constituting the three autumn months, was $49^{\circ}8$, being $0^{\circ}4$ above the average of the preceding 91 years.

THE WEATHER DURING THE QUARTER ENDING DECEMBER 31, 1862.

1862. MONTHS.	Temperature of										Elastic Force of Vapour.		Weight of Vapour in a Cubic Foot of Air.	
	Air.		Evaporation.		Dew Point.		Air—Daily Range.							
	Mean.	Diff. from average of 21 years.	Mean.	Diff. from average of 21 years.	Mean.	Diff. from average of 21 years.	Mean.	Diff. from average of 21 years.						
	October ..	51.8	+2.3	0	+1.8	0	+2.4	0	+0.2	in.	.343	grs.	3.8	gr.	+0.1
November ..	39.8	-2.6	38.8	-2.9	37.4	-2.6	11.5	-0.2		.224		2.5		-0.4
December ..	43.6	+4.6	42.1	-3.5	40.3	+3.4	9.4	-0.1		.250		2.8		+0.2
Mean ..	45.0	+1.4	43.7	+0.8	42.1	+1.0	11.9	0.0		.272		3.0		0.0

1862. MONTHS.	Degree of Humidity.		Reading of Barometer.		Weight of a Cubic Foot of Air.		Rain.		Tempera- ture of Water of the Thames.		Number of Nights it was				Reading of Thermometer on Grass.	
	Mean.	Diff. from average of 21 years.	Mean.	Diff. from average of 21 years.	Mean.	Diff. from average of 21 years.	Amount.	Diff. from average of 46 years.	Mean.	At or below 30°.	Between 30° and 40°.	Above 40°.	Lowest Reading at Night.	Highest Reading at Night.		
	October ..	89	+2	in.	in.	grs.	in.	in.	0	3	9	19	0	0	0	
November ..	92	+3	29.726	+0.029	-1	4.0	+2.2	55.4	55.4	14	12	4	25.0	52.5		
December ..	88	-1	29.793	+0.046	+6	1.0	-1.4	44.1	44.1	9	15	7	18.0	47.0		
Mean ..	89	+1	29.865	+0.052	-2	1.6	-0.3	42.2	42.2	Sum	Sum	Sum	Lowest	Highest		
						Sum	Sum	Sum	Mean	26	36	30	18.0	52.5		

NOTE.—In reading this table it will be borne in mind that the sign (-) minus signifies below the average, and that the sign (+) plus signifies above the average.

STATE OF THE PUBLIC HEALTH.

1st Quarter.—The total number of deaths in the quarter was 92,225. In the same quarter of 1860 it did not much exceed 86,000; in that of 1861 it was about 101,000. The cold summer of this year was less healthy than the still colder summer of 1860; but it was healthier than the warmer summer of last year. The annual rate of mortality in the quarter was 1·797 per cent. of the population, against an average of 2·020 per cent. In the country districts the mortality was 1·586 (the average being 1·747); whilst in urban populations it was 2·011 (the average being 2·328).

2nd Quarter.—The number of deaths in the three months ending 31st December was 114,542. In the corresponding season of 1860 it was nearly 103,000; in that of 1861 nearly 105,000. Though the autumn of 1862 was not as a whole colder than those which preceded it, the sudden invasion of cold in November and the abrupt succession of heat account for its having been the most fatal. The death-rate was 2·226 per cent. (against an average of 2·171). In the principal towns the rate of mortality was 2·53 per cent. (against an average of 2·47); and in the small towns and country parishes 1·92 per cent. (against an average of 1·90).

PRICE OF PROVISIONS.

1st Quarter.—The average price of wheat was 56s. 10d. per quarter; in the same period of last year the price was 52s. 1d. The average of the highest and lowest prices of beef at Leadenhall and Newgate Markets was 5½d. per lb., and of mutton 6½d. Best potatoes were 115s. per ton at the Waterside Market, Southwark; they were dearer than they had been at the same time last year.

2nd Quarter.—The average price of wheat in the three months was 48s. 2d. per quarter, which is less by 8s. 7d. than in the corresponding period of 1860, and less by 11s. 1d. than in that of 1861. The price of beef at Leadenhall and Newgate Markets was 5½d. per lb.; the same as in the corresponding quarter of 1861; of mutton 6d., or one farthing per lb. cheaper than in the same quarter of the previous years. The average price of the best potatoes was 100s. per ton, which is less by 20s. than it was in the last quarter of the two previous years.

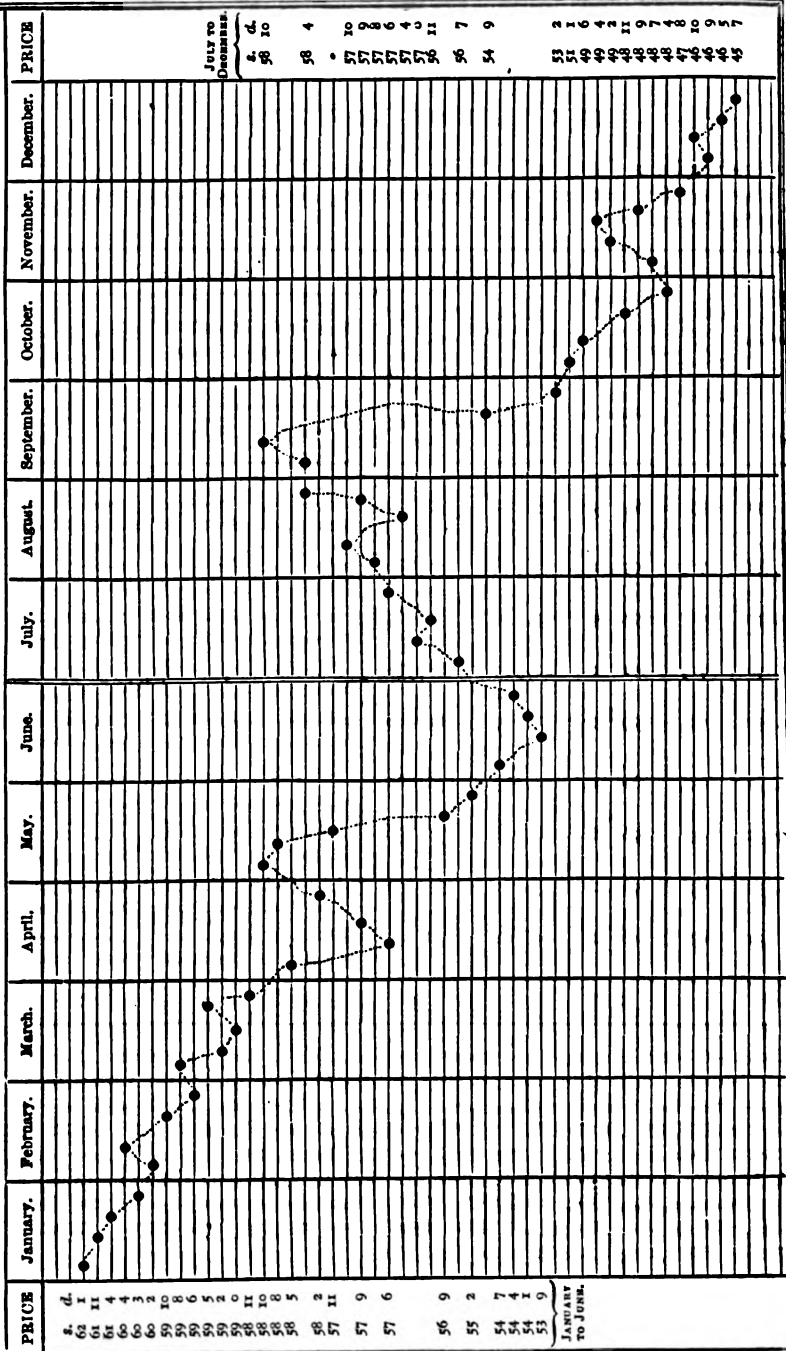
THE PRICE OF PROVISIONS.

The AVERAGE PRICES of Consols, of Wheat, Meat, and Potatoes; also the AVERAGE QUANTITY of Wheat sold and imported weekly, in each of the Nine Quarters ending December 31, 1862.

Quarters ending	Average Price of Consols (for Money).	Average Price of Wheat per Quarter in England and Wales.	Wheat sold in the 290 Cities and Towns in England and Wales making Returns.*	Wheat and Wheat Flour entered for Home Consumption at Chief Ports of Great Britain.*	Average Prices of		
					Meat per lb. at Leadenhall and Newgate Markets (by the Carcase).	Best Potatoes per Ton at Waterside Market, Southwark.	
						Beef.	Mutton.
1860 Dec. 31	£. 93½	s. d. 56 9	73,770	197,396	3½d.—6½d. Mean 4½d.	4½d.—6½d. Mean 5½d.	115s.—130s. Mean 122s. 6d.
1861 Mar. 31	91½	55 1	69,588	145,880	4d.—6½d. Mean 5½d.	5½d.—7½d. Mean 6½d.	140s.—155s. Mean 147s. 6d.
June 30	91½	54 9	65,176	134,085	4½d.—6½d. Mean 5½d.	5½d.—7½d. Mean 6½d.	120s.—140s. Mean 130s.
Sept. 30	91½	52 1	82,383	128,336	4½d.—6½d. Mean 5½d.	4½d.—7d. Mean 5½d.	85s.—110s. Mean 97s. 6d.
Dec. 30	93½	59 3	112,809	121,480	4d.—6½d. Mean 5½d.	4½d.—6½d. Mean 5½d.	110s.—130s. Mean 120s.
1862 Mar. 31	93½	60 1	74,163	132,882	4d.—6½d. Mean 5½d.	4½d.—6½d. Mean 5½d.	130s.—155s. Mean 142s. 6d.
June 30	93½	56 8	58,728	136,230	4d.—6d. Mean 5d.	5d.—7d. Mean 6d.	180s.—200s. Mean 190s.
Sept. 30	93½	56 10	57,592	295,276	4½d.—6½d. Mean 5½d.	5½d.—7d. Mean 6½d.	100s.—130s. Mean 115s.
Dec 31	93½	48 2	85,522	258,095	4d.—6½d. Mean 5½d.	5½d.—6½d. Mean 6d.	90s.—110s. Mean 100s.
Col.	1	2	3	4	5	6	7

* NOTE.—The total number of quarters of wheat sold in England and Wales for the 13 weeks ending December 31st, 1860, was 959,006; for the 13 weeks ending March 31st, 1861, 904,649; for the 13 weeks ending June 30th, 1861, 847,285; for the 13 weeks ending September 30th, 1861, 1,070,985; for the 13 weeks ending December 31st, 1861, 1,466,525; for the 13 weeks ending March 31st, 1862, 964,121; for the 13 weeks ending June 30th, 1862, 763,463; for the 13 weeks ending September 30th, 1862, 748,702; and for the 13 weeks ending December 31st, 1862, 1,111,787. The total number of quarters entered for Home Consumption was respectively, 2,566,145; 1,896,435; 1,743,100; 1,668,374; 1,579,241; 1,727,464; 1,770,998; 3,838,584; and 3,355,239.

1862.—WEEKLY AVERAGE PRICE OF WHEAT FROM GOVERNMENT RETURNS.



Average of Year
 WHEAT. 55/6
 BARLEY. 35/3
 OATS. 22/7
 BEANS. 39/11
 PEAS. 40/3
 MAIZE. ..
 FLOUR AND MEAL. ..

STATISTICS
OF
THE WEATHER, PUBLIC HEALTH, PRICE OF
PROVISIONS, &c., &c.,
FOR THE SIX MONTHS ENDING JUNE 30, 1863.

*Chiefly extracted from the Quarterly Report of the Registrar-General.—
The Corn Returns are prepared from Official Documents expressly for this
Journal.*

(X)

ON
THE METEOROLOGY OF ENGLAND

DURING

THE QUARTER ENDING MARCH 31, 1863.

By JAMES GLAISHER, Esq., F.R.S.,

SEC. OF THE BRITISH METEOROLOGICAL SOCIETY.

With the exception of the period between March 9th and 19th, when the temperature was below the average to the amount of $2\frac{1}{2}^{\circ}$ daily, the weather was warm throughout the quarter, averaging a daily excess of $4\frac{1}{4}^{\circ}$ for the remaining 79 days.

The mean temperature of the 3 months was $42^{\circ}\cdot6$; in 1834 it was $42^{\circ}\cdot9$; in 1846 it was $43^{\circ}\cdot6$; and these are the only instances, so far as trustworthy records extend, of an excess over the temperature of the first three months of the present year. The mean temperature of January was $41\frac{1}{4}^{\circ}$; of February, $42^{\circ}\cdot1$; of March, $43^{\circ}\cdot9$.

The mean high day temperature was in excess $3^{\circ}\cdot8$, $4^{\circ}\cdot6$, and $3^{\circ}\cdot7$ respectively in the three months. The mean low night temperature was in excess $3^{\circ}\cdot2$, $2^{\circ}\cdot2$, and $0^{\circ}\cdot2$ respectively. Therefore both days and nights were warm in January and February; in March the days were warm, and the nights about their average.

The mean temperature of the air in January was $5^{\circ}\cdot2$, in February $3^{\circ}\cdot6$, and in March $2^{\circ}\cdot6$, above the average of 43 years.

The temperature of the dew-point in January, February, and March respectively was $2^{\circ}\cdot4$, $3^{\circ}\cdot2$, and $0^{\circ}\cdot9$, above the average of the preceding 22 years.

The pressure of the atmosphere was in defect in January and March, and in excess in February.

The fall of rain in the south of England in January was somewhat in defect, a little over its average about London, and very much in excess in the north. All over the country February and March were remarkably fine and mild.

The mean temperature of the air at Greenwich in the three months ending February, constituting the three winter months, was $42^{\circ}\cdot5$, being $4^{\circ}\cdot7$ above the average of the preceding 91 years.

ON THE METEORÔLOGY OF ENGLAND

DURING

THE QUARTER ENDING JUNE 30, 1863.

BY JAMES GLAISHER, Esq., F.R.S.,

SEC. OF THE BRITISH METEOROLOGICAL SOCIETY.

TILL May 17th, except two days at the beginning of April and five days at the end of April and the beginning of May, the temperature was in excess 2° daily. Between May 18th and May 26th, the average daily deficiency was 6° ; for a like period the average daily excess was $3\frac{1}{2}^{\circ}$; and from June 5th to the end of the quarter the average deficiency amounted to $2\frac{1}{2}^{\circ}$ daily.

The average monthly temperature of the air, from December, 1862, to April, 1863, was $44^{\circ}\cdot 1$; in no other similar period, from 1771, has the temperature been so high, so that we may fairly conclude that the temperature for the five months ending April of this year is as high as any on record.

The mean temperature of April was $49^{\circ}\cdot 1$, being higher than in any April since 1844.

The mean temperature of May was $52^{\circ}\cdot 0$, being $3^{\circ}\cdot 4$ lower than in 1862, and of nearly the same value as in 1861.

The mean temperature of June was $58^{\circ}\cdot 1$, being $1^{\circ}\cdot 8$ higher than in 1862, and 1° lower than in 1861.

The mean high day temperature in April was $4\frac{1}{2}^{\circ}$ in excess; in May nearly its average; in June $0^{\circ}\cdot 9$ in defect. The mean low night temperature in April was $1\frac{1}{2}^{\circ}$ in excess; in May $1\frac{1}{2}^{\circ}$ in defect; and of nearly its average in June. Therefore both the days and nights in April were warm, and the nights in May; and the days in June were cold.

The mean temperature of the air in April was $2\frac{1}{2}^{\circ}$ in excess; in May 1° in defect; and in June 1° in defect.

The mean temperature of the dew point in April was $2\frac{1}{2}^{\circ}$ in excess; in May $0^{\circ}\cdot 5$ in defect; and in June $0^{\circ}\cdot 7$ in defect.

The degree of humidity and the readings of the barometer differed but very little from their monthly average values in any of the months.

The mean temperature of the air at Greenwich in the three months ending May, constituting the three spring months, was $48^{\circ}\cdot 3$, being $1^{\circ}\cdot 9$ above the average of the preceding 92 years.

THE WEATHER DURING THE QUARTER ENDING JUNE 30, 1863.

1863. MONTHS.	Temperature of										Elastic Force of Vapour.		Weight of Vapour in a Cubic Foot of Air.		
	Air.		Evaporation.		Dew Point.		Air—Daily Range.								
	Mean.	Diff. from average of 22 years.	Mean.	Diff. from average of 22 years.	Mean.	Diff. from average of 22 years.	Mean.	Diff. from average of 22 years.	Mean.	Diff. from average of 22 years.	Mean.	Diff. from average of 22 years.			
	°	°	°	°	°	°	°	°	°	°	grs.	gr.			
April ..	49.1	+3.3	46.0	+3.6	42.7	+3.6	21.1	+3.0	21.1	+3.0	.274	+.036	3.1	+0.2	
May ..	52.0	-0.5	48.6	-0.6	45.2	-0.4	21.7	+1.5	21.7	+1.5	.302	-.001	3.4	-0.1	
June ..	58.1	0.0	53.9	-0.8	50.2	-0.7	20.0	-0.8	20.0	-0.8	.364	-.009	4.1	-0.1	
Mean ..	53.0	+0.9	49.5	+0.4	46.0	+0.5	20.9	+1.2	20.9	+1.2	.313	+.005	3.5	0.0	
1863. MONTHS.	Degree of Humidity.		Reading of Barometer.		Weight of a Cubic Foot of Air.		Rain.		Tempera- ture of Water of the Thames.		Number of Nights it was			Reading of Thermometer on Grass.	
	Mean.	Diff. from average of 22 years.	Mean.	Diff. from average of 22 years.	Mean.	Diff. from average of 22 years.	Amount.	Diff. from average of 46 years.	Mean.	Diff. from average of Thames.	At or below 30°.	Between 30° and 40°.	Above 40°.	Lowest Reading at Night.	Highest Reading at Night.
	°	°	in.	in.	grs.	grs.	in.	in.	°	°				°	°
	°	°	in.	in.	grs.	grs.	in.	in.	°	°				°	°
April ..	78	-1	29.813	+0.061	543	+1	0.4	-1.4	52.4	52.4	9	15	6	19.4	46.7
May ..	78	+1	29.857	+0.090	540	+2	1.3	-0.8	55.3	55.3	6	12	13	22.4	53.4
June ..	75	0	29.727	-0.063	531	0	3.9	+2.0	61.8	61.8	0	6	24	36.1	53.4
Mean ..	77	0	29.799	+0.029	538	+1	5.6	-0.2	Mean	Mean	Sum	Sum	Sum	Lowest	Highest
									56.5	56.5	15	33	43	19.4	53.4

Notes.—In reading this table it will be borne in mind that the sign (-) minus signifies below the average, and that the sign (+) plus signifies above the average.

STATE OF THE PUBLIC HEALTH.

1st Quarter.—A winter remarkably “mild” was also remarkably unhealthy. The deaths in England in the three months ending 31st March were 128,524, against 122,192 in the same period of 1862, which supplies an example of average health in winter, and may be taken as a means of comparison. It will be an approximation to the truth, to state that people died in the quarter at the rate of 20,000 in a year, whose lives would have been saved if epidemics or atmospheric causes of a nature unfavourable to health had not been in greater force than usual. The rate of mortality was 2·546 per cent., the average being 2·498. The mortality of small towns and rural districts was 2·343 per cent. (against an average of 2·287). That of the chief towns was 2·705 per cent. (against an average of 2·688). The country appears to have suffered from the effects of the winter more than the town.

2nd Quarter.—After a period of two years in which the public health was better than usual, the mortality rose in the last three months of 1862, was high in the first three months (the winter quarter) of the current year, and continued above the average in the second quarter. In this last period the death-rate was 2·313 per cent. per annum, whilst the average was 2·191. With the present exception, a spring quarter has not occurred since the year 1858 in which the rate of mortality was as high as 2·3.

Both town and country testify to an increase of deaths in their respective populations; for the rate in the chief towns was 2·478 (against an average of 2·336), and that which prevailed in small towns and country parts was 2·102 (against 2·031). Summer-like weather in the early year, and cold days or nights striking a sudden chill into the heart of it, produce effects from which neither city nor hamlet is exempt.

PRICE OF PROVISIONS.

1st Quarter.—Wheat was cheap. The average price was 46s. 7d. per quarter. In the corresponding period of the year 1861 it was 55s. 1d.; while in that of the year 1862 it was 60s. 1d. Beef was near its usual price; the average lowest and highest prices of mutton at Leadenhall and Newgate Markets were 5d. and 7d. per lb. by the carcase. Potatoes were cheaper than they have recently been at this season, the best having been sold at the Waterside Market, Southwark, at about 125s. per ton.

2nd Quarter.—Wheat was still remarkably cheap: the average price fell to 46s. 2d. per quarter, against 56s. 8d. in the same period of 1862. The lowest and highest prices of beef at Leadenhall and Newgate were 4½d. and 6½d. per lb. sold by the carcase. In the same period of 1862 they were 4d. and 6d. During the last twelve months the average price of the best quality has not varied. The price of mutton fell. In the June quarter of 1862 the worst and best qualities were 5d. and 7d. per lb.; and they were near those prices in the succeeding nine months, till last quarter, when they were 4½d. and 6½d. The average price of the best potatoes at the Waterside Market, Southwark, was 120s. per ton, against 190s. in the same quarter of 1862. Beef furnishes the only exception to the comparative cheapness of the principal articles of food.

THE PRICE OF PROVISIONS.

The AVERAGE PRICES of Consols, of Wheat, Meat, and Potatoes; also the AVERAGE QUANTITY of Wheat sold and imported weekly, in each of the Nine Quarters ending June 30, 1863.

Quarters ending	Average Price of Consols (for Money).	Average Price of Wheat per Quarter in England and Wales.	Wheat sold in the 290 Cities and Towns in England and Wales making Returns.*	Wheat and Wheat Flour entered for Home Consumption at Chief Ports of Great Britain.*	Average Prices of		
					Meat per lb. at Leadenhall and Newgate Markets (by the Carcase).		Best Potatoes per Ton at Waterside Market, Southwark.
					Beef.	Mutton.	
1861 June 30	£. 91½	s. d. 54 9	65,176	134,085	4½d.—6½d. Mean 5½d.	5½d.—7½d. Mean 6½d.	120s.—140s. Mean 130s.
Sept. 30	91½	52 1	82,383	128,336	4½d.—6½d. Mean 5½d.	4½d.—7d. Mean 5½d.	85s.—110s. Mean 97s. 6d.
Dec. 30	93½	59 3	112,809	121,480	4d.—6½d. Mean 5½d.	4½d.—6½d. Mean 5½d.	110s.—130s. Mean 120s.
1862 Mar. 31	93½	60 1	74,163	132,882	4d.—6½d. Mean 5½d.	4½d.—6½d. Mean 5½d.	130s.—155s. Mean 142s. 6d.
June 30	93½	56 8	58,728	136,230	4d.—6d. Mean 5d.	5d.—7d. Mean 6d.	180s.—200s. Mean 190s.
Sept. 30	93½	56 10	57,592	295,276	4½d.—6½d. Mean 5½d.	5½d.—7d. Mean 6½d.	100s.—130s. Mean 115s.
Dec. 31	93½	48 2	85,522	258,095	4d.—6½d. Mean 5½d.	5½d.—6½d. Mean 6d.	90s.—110s. Mean 100s.
1863 Mar. 31	..	46 7	75,819	139,429	4d.—6d. Mean 5d.	5d.—7d. Mean 6d.	120s.—130s. Mean 125s.
June 30	..	46 2	82,458	106,633	4½d.—6½d. Mean 5½d.	4½d.—6½d. Mean 5½d.	110s.—130s. Mean 120s.
Col.	1	2	3	4	5	6	7

* NOTE.—The total number of quarters of wheat sold in England and Wales for the 13 weeks ending June 30th, 1861, was 847,285; for the 13 weeks ending September 30th, 1861, 1,070,985; for the 13 weeks ending December 31st, 1861, 1,466,525; for the 13 weeks ending March 31st, 1862, 964,121; for the 13 weeks ending June 30th, 1862, 763,463; for the 13 weeks ending September 30th, 1862, 748,702; for the 13 weeks ending December 31st, 1862, 1,111,787; for the 13 weeks ending March 31st, 1863, 985,649; and for the 13 weeks ending June 30th, 1863, 1,073,126. The total number of quarters entered for Home Consumption was respectively, 1,743,100; 1,668,374; 1,579,241; 1,727,464; 1,770,998; 3,838,584; 3,355,239; 1,812,585; and 1,386,233.

CONTENTS OF PART I., VOL. XXIV.

STATISTICS :—

	PAGE
Meteorology, for the six months ending December 31, 1862 ..	II
Public Health ditto ditto	VI
Price of Provisions ditto ditto	VI
Weekly Average of Wheat	VIII

ARTICLE ..

	PAGE
I.—Land Valuing. By Philip D. Tuckett, F.G.S., Prize Essay ..	1
II.—The Prize Farms of France. By P. H. Frere	8
III.—Absorption of Soluble Phosphate of Lime by different Soils of known composition; and Remarks on the Application of Superphosphate and other Phosphatic Manures to Root-crops. By Dr. Augustus Voelcker	37
IV.—Utilisation of Town Sewage. By J. B. Lawes, F.R.S., F.C.S.	65
V.—Supply of Horses Adapted to the Requirements of the English Army; with Notes on the Remount System in the French Army. By J. Wilkinson	91
VI.—Experiments with different Top-Dressings upon Wheat. By Dr. Augustus Voelcker	100
VII.—Earth <i>versus</i> Water for the Removal and Utilisation of Excrementitious Matter. By the Rev. Henry Moule	111
VIII.—The Money-Value of Night-Soil and other Manures. By P. H. Frere	124
IX.—Effects of different Manures on the Mixed Herbage of Grass-land. By J. B. Lawes, F.R.S., F.C.S., and J. H. Gilbert, Ph. D., F.R.S., F.C.S.	131
X.—Co-operative Farms at Assington, Suffolk	165
XI.—Review of 'Italian Irrigation, by R. Baird Smith, Captain of Engineers, Bengal Presidency, F.G.S.' By P. H. Frere ..	173
XII.—Statistics of Live-Stock for Consumption in the Metropolis. By Robert Herbert	206
XIII.—Some Account of Brittany Cows. Taken from Notices by M. Jamet, of Rennes. By P. H. Frere	213

no F.C. Read

CONTENTS.

ARTICLE	PAGE
XIV.—Cultivation of Carrots and Cabbages for the Feeding of Stock. By C. Lawrence	216
XV.—Experiments on Transplanting Mangold. By W. Gurdon ..	221
XVI.—Growth of Barley after a Grass-layer. By P. H. Frere ..	225
—————	
Abstract Report of Agricultural Discussions :—	
Splenio Apoplexy	228

APPENDIX.

List of Officers of the Royal Agricultural Society of England, 1863 ..	i
Standing Committees for 1863	iii
Memoranda of Meetings, Payment of Subscription, &c.	v
Report of the Council to the General Meeting, December 11, 1862 ..	vi
London Show Account	ix
Cash Account and Balance-sheets, ending December 31, 1862 ..	x—xiii
Schedule of Prizes : Worcester Meeting, 1863	xiv
Distribution of Prizes in Heifer Classes, Battersea Show	xxiv
Prizes for Essays	xxv
Members' Chemical Analysis and Veterinary Privileges	xxix, xxx

DIRECTIONS TO THE BINDER.

The Binder is desired to collect together all the Appendix matter, with Roman numeral folios, and place it at the end of each volume of the Journal, excepting Titles and Contents, and Statistics &c., which are in all cases to be placed at the beginning of the Volume: the lettering at the back to include a statement of the year as well as the volume; the first volume belonging to 1839–40, the second to 1841, the third to 1842, the fourth to 1843, and so on.

In Reprints of the Journal all Appendix matter (and in one instance an Article in the body of the Journal), which at the time had become obsolete, were omitted; the Roman numeral folios, however (for convenience of reference), being reprinted without alteration in the Appendix matter retained.

JOURNAL

OF THE

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

I.—*On Land Valuing.* By PHILIP D. TUCKETT, F.G.S.,
Land Agent and Surveyor.

PRIZE ESSAY.

SUCH striking inequalities are constantly observable in the rentals at which farms are let throughout the country, that it is by no means surprising that the Royal Agricultural Society should desire to obtain some reliable information as to the principles on which the rental-value of land should be calculated. Yet the art of land-valuing is one that depends so entirely on the individual judgment and experience of the valuer, that it is really impossible to lay down any rules that can materially assist those who do not possess these requisite qualifications.

It is probable that these pages do not contain so much of detailed calculation as may be expected by the Society, it being my conviction that such detailed estimates, although often extremely interesting, can never be relied on for practical purposes. The following observations are offered as the result of the experience of the last twelve years, during which I have been employed in valuing land in thirty-nine of our English and Welsh counties; and it has been my object (neglecting minute details) to enumerate the main considerations that must influence the practical valuer.

In arriving at the rental value of land, the duty of the valuer may be considered under three heads :—

- 1st. Accurately to ascertain the quality of the soil.
- 2nd. To take into account the various other circumstances that affect the value.
- 3rd. To assess the value in money.

The various indications of the fertility and barrenness of soils are so ably discussed in Mr. Bravender's admirable paper in the 5th volume of the Society's Journal, that it would be superfluous again to go over the several points there enumerated; but it appears to me that, in reading so long and minute a description of these various indications, there is some danger of forgetting

how much greater is the importance of some of these considerations than of others; and I wish, therefore, to draw attention to those differences which *mainly* influence the quality of land. The quality of a soil may be said *primarily* to depend on its mechanical composition and depth. Land must always remain poor so long as there is but a very shallow surface-soil—the compact uncultivated subsoil ‘coming nearly to the top, whether it be a thin-skinned clay, a thin gravel, or a sharp sand. So in the case of two soils of similar texture, that which has the greatest depth will be the most fertile. All fertile soils are composed of a mixture of clay, lime and sand, forming, when mixed in good proportions, a sandy loam or clay loam, as the case may be; and when one element is greatly in excess, a sharp gravel or sand, a stiff clay or a tenacious marl; or where the lime is almost absent, the weak clay soils, so characteristic of the lower silurian slate-rocks.

There is no doubt that the other substances contained in a soil also have their effect, and in a few cases, where a noxious substance is present, or where vegetable matter largely exists, this influence is considerable; but in these cases indirect indications of the state of the case are not wanting—for in the former the stunted trees and unhealthy vegetation, and in the latter the dark colour of the soil, tell their own tale.

Most soils naturally contain a small quantity of phosphate of lime, or other fertilising agents; but such supplies are liable to exhaustion, and, as in a country like England, where the land has been long cultivated, we depend to a great extent upon the air and upon the manure applied for the food of plants, the great essential to fertility is a soil of sufficient depth, having such a mechanical texture as is best adapted for a good seed-bed, resting on a subsoil which, whilst providing good drainage, does not allow the manure applied to pass downward too quickly. Thus some of our primeat grazing lands have a stiff (almost a clay) soil, resting on a bed of gravel. If the gravel came near to the surface, the land would be poor and hungry; if the subsoil were stiff, the land would be wet and cold.

A knowledge of the geological formation on which the land is situate will go far towards enabling the valuer to allow for differences in the chemical composition of apparently similar soils; for I have observed a marked difference in the fertility of soils of similar texture, which lay on different formations, maintaining itself even in distant counties. Thus it will be found that soils resting on the lower oolite or lias formations are slightly more fertile than similar ones on the middle oolite (or indeed on almost any other formation), the difference between the lias and Oxford clays being particularly observable.

Considering how rich in fossils are the lias formation, and also the shaly limestone-beds of the inferior oolite, I cannot but regard this difference as due to the presence of phosphate of lime. Some soils resting on the greensand may also be instanced as especially fertile from this cause.

Again, the Weald clays are less fertile, and the London clays rather more so, than their appearance would indicate.

Dark-coloured soils (unless very weak and porous) have an advantage, inasmuch as they absorb more of the sun's heat, in addition to which the dark colour generally indicates the presence of organic matter. But some dark-coloured dry sandy soils are injuriously affected from the same cause, because from excessive evaporation they more quickly lose the moisture which they especially need.

Then the climate, aspect, elevation above the sea-level, and especially the wetness or dryness of the soil, and, if it be wet, the facilities for drainage, will be most important considerations; and any liability to flood should be carefully ascertained and taken into account.

Still it is well to bear in mind, as a general rule, however subject to modification, that the intrinsic or natural quality of a soil *mainly* depends on its depth and *mechanical* composition.

Now, it happens that these qualities may readily be ascertained by examining the soil and subsoil with a spade or strong walking-stick, the mechanical texture of the soil being as readily judged of, by a man of experience, as a sample of any other commodity; and there can be no doubt that the surest method of judging of the quality of the land is by an examination of the soil itself, rather than of anything that grows upon it.

In valuing grass land, indeed, an examination of the herbage forms a valuable criterion; and I can but again refer to Mr. Bravender's excellent paper, which I have found most useful in examining the different grasses which make up the sward of a meadow or pasture, and the weeds which characterise particular soils.

But it is also well to observe the growth of the same grasses on different land: thus on dry burning land the ordinary grasses grow thin and wiry.

The sward of the best grazing land will be found to consist almost wholly of true grasses, and these chiefly the best meadow grasses: *Alopecurus pratensis* (meadow fox-tail grass), *Dactylis glomerata* (rough cock's-foot grass), *Festuca pratensis* (meadow fescue grass), *Phleum pratense* (common cat's-tail grass), *Cynosurus cristatus* (Crested dog's-tail grass), *Anthoxanthum odoratum* (Sweet-scented vernal grass), which gives its odour to hay, and a few others. Leafy plants, if there be no other objection to

them, take up too much room. Such land looks green much later in the year than inferior pasture, and when it at length loses its bright colour, it acquires a slightly whitish tinge, but never a brown or reddish hue.

Clover is generally a good sign, and so are buttercups; but *much* moss indicates poverty, and often too frequent mowing, although most grass fields contain *some* moss.

The strong coarse grasses that indicate wet land are well known; but I may remark that although rushes thrive on wet soils, they survive draining, and are much too universal on cold grass land to form a sure indication: they should not, therefore, be relied on as Carnation Grass, Tufted-hair Grass, the Woad-plant, or Blue-buttons may be.

The appearance of the trees and hedges should also be noted. Neither elms nor quick-hedges will ever be seen growing strong and well on very bad land. Oaks indicate a strong soil or subsoil, generally clay, and the appearance of the trees will often indicate the quality.

But even in the case of grass land, it is also desirable to examine the soil and subsoil. In how many cases do we find that these are of a much better quality than we anticipated from the nature of the herbage above them—the result of years of bad management, scarcely to be cured without breaking up!

In the case of arable land, an examination of the soil and subsoil is the only reliable test; and I do not hesitate to say that if a valuer allows himself to be influenced in any degree by the appearance of the crops, he runs the greatest risk of being misled.

This being the case, there need be no difficulty in “reducing lands under different systems of culture to the same standard of calculation.” That a long-continued system of deep ploughing and superior culture will eventually alter the *apparent* quality of the soil, I do not deny; for it ought to do so, seeing that it will also permanently alter its *real* quality. But if the soil be carefully examined, the valuer will not be at all misled by such differences as that between one field in clover ley, trodden down hard, and an adjoining one ploughed up rough. The season most favourable for inspection is that in which the land can be best seen, when it is least encumbered by crops, and not locked up by frost or snow. I should say that any time from the 1st of September to the middle of May is favourable for land-valuing, excluding only periods of frost and snow and excessive rain; and on this account probably the months of September, October, March, and April, may be the best of all. During the summer months the difficulty and labour of arriving at a correct estimate are increased, although from the idea that land looks better with the crops upon it, and the circumstance that that is the usual season for the sale of

estates, a great deal of land-valuing is done at that period of the year.

I trust I have now pointed out the *leading* features by which the qualities of soils can be recognised; but nothing but extended observation and experience can enable a valuer to arrive at certain results. I have often heard the remark made by farmers that no man can tell the quality of land by only seeing it once. This I do not wonder at, because those who have expressed this opinion have been men who were accustomed to judge of land rather by what was upon it than by the land itself. But if an examination of the soil itself is relied on, which is the only safe method, I believe one careful inspection is quite sufficient; a careful one it should be, and it is idle to suppose that any man can detect the numerous, and in some districts very sudden, variations that occur, by merely riding or driving hastily over the land, as is sometimes done.

Having ascertained the quality of each field, there are yet a number of circumstances to be considered affecting the value of the farm. The extent and arrangement of the agricultural buildings very materially affect the value; the situation of the lands with respect to each other, and to the homestead, and how far each field is approached by a hard road, are material points, as affecting the expense of horse-labour; as are also the distance from a market town, and the quality of the public roads, and the supply and price of labour in the district.

Where lands are situate so near to a large town as to partake of anything approaching an accommodation character, of course this must be a most important point; but in ordinary situations, where corn and meat are the staple products, the price of these commodities will not vary so much as greatly to affect the value of the land.

To allow for the parochial and other charges upon a farm, is a mere matter of calculation. I believe the most convenient method in practice is to value the land as tithe-free, and as subject to average parochial rates, say 3s. in the pound, on an assessment of two-thirds of the full value, and afterwards to deduct the tithe rent-charge, and allow for any excess or otherwise in the average parochial rates.

I now come to "the estimates which ought to form the basis of calculation in fixing the rental of land."

From the wording of the Society's notice, I presume that a similar idea was entertained to that expressed by Mr. Robert Baker, in his edition of 'Bayldon on Rents and Tillages,' page 59, where he says that the fair rent, "*it is presumed*, may be obtained by estimating the expenses incurred and the profits arising during the whole course of one rotation of crops on different soils," and

he gives a table to show the proportion of rent to produce on different qualities of land. He admits that experienced valuers do not in practice make use of such calculations, and that their estimates often agree within 1s. per acre; but he seems to think that less-experienced persons should test their opinions in this way. But further on he admits that it will require *great practical experience* to enter on these needful calculations.

Others have entertained the same idea, and there can be no doubt that the difference between the produce and the expenses incurred must, in the end, regulate the rent that a farmer can afford to pay.

Such calculations are very interesting, and I have often made them for my own satisfaction; but I am firmly convinced that they can never be carried out with sufficient accuracy to form a practical guide to the land-valuer, and I know that this is also the opinion of several eminent valuers, with whom I have conversed on the subject. Indeed, my chief object in submitting this paper to the Society is to point out the fallacy of expecting reliable practical results from this source.

The produce of a farm depends very much on the way in which it is managed, and a *slight* error in the estimate of the produce will materially alter the result of the calculation. Many men can calculate to a nicety the yield of a crop before harvest; but who can accurately estimate the produce of a farm during a series of years?

The same remarks, though in a less degree, apply to the estimated expenses; and by such calculations as these almost any given result may be arrived at. The course of cropping habitually pursued in a district may in some instances be a valuable general indication of the quality of the soil; as where a tract of alluvial land continues to produce large crops under a rotation which would ordinarily be regarded as "scourging," we may safely infer that it contains extraordinary supplies of fertilising matter—a conclusion which will be confirmed on an examination of the soil itself.

But, after all, the true value of an article is what it will fetch in the market; and I see no reason why this principle should not apply to the rent of land as to everything else. Not that the fair rent is the highest sum that some reckless speculator can be induced to give for it, who will probably get all he can out of it for a few years, and then leave it in deteriorated condition, but that amount of rent which can readily be obtained from a substantial, respectable tenant during a series of years. Such men will not give so high a rent for a farm as will deprive them of the means of living; on the other hand, competition will induce them to give as much as they can afford. In this way the rent

of land is regulated from time to time by actual experience, far better than it could be by the most elaborate calculations.

Of course, many farms are let privately to the person to whom the first offer is given, and there is no direct evidence that a full rent has been obtained; yet every experienced land-valuer can readily compare in his mind almost any description of land with farms of similar quality in different localities, which he has previously valued and let, where there has been sufficient competition on the one hand, or difficulty in finding a suitable tenant on the other, to form a test of value. The negotiations connected with such lettings serve from time to time to confirm or correct the judgment, and afford a far more practical test of the value of the various descriptions of land, than any calculations that can be made:

Such is at present the basis on which the rental value of land is usually calculated, and I do not see how it is possible to obtain any better or more practical one, whether or not it exactly corresponds to the true standard of value; for I believe that the rent which can be obtained for poor thin-skinned clays, low as it may seem, is yet higher in proportion to their true value than that which can be obtained for really good land, high as that may appear. But if farmers in general underrate the difference, it is beyond the power of the land-valuer to alter their views. Still, if such a discrepancy does exist, it should be his object rather to correct than to exaggerate it; and there can be no doubt that, without care, there is great danger of valuing the best soils considerably below, and the inferior ones above, their real value.

In connexion with this subject, I may allude to the gradual but steady increase in the value of land. Improved modes of cultivation, which have greatly increased the produce, have done much in this direction; drainage and steam-cultivation are now effecting for our clays what turnips and sheep have already done for our heaths and downs. But, besides this, as long as the population increases and manufactures flourish, so long must the value of land continue to advance. And still more important, in my opinion, as respects the money value of land and produce, is the enormous and continued production of gold in British Columbia, Australia, California, &c. Already do we see a marked difference in the relative values of gold and silver in France. The increased value of tithe rent-charge points in the same direction, and though the effect may not be rapid, yet I believe it is a consideration which ought to influence the question of long leases, and that it is not wise in landlords to grant terms of twenty-one years without protecting themselves by a corn-rent.

76, Old Broad-street, London, April, 1862.

II.—*The Prize Farms of France.* By P. H. FRERE.

MANY circumstances tend to give us a lively and increasing interest in French agriculture. The same rule applies to the two empires parted by the British Channel as to all subdivisions, whether natural or scientific, viz., that in some respects parts of the bodies which have been severed are more akin than certain of the members of the same body or group. In ease of access to either metropolis and its markets, in soil, in climate, and products, perhaps even in race, the two shores of the Channel stand in nearer relation to each other than the one to Ireland or Scotland, or the other to Provence, Savoy, and the Pyrenees.

Again, if contrasts teach us only less pointedly than patterns, we may have much to learn from the South of France, which seems designed in some measure to play, under different conditions, the same part as our North-Western Provinces; for whilst the adjacent parts of the two empires form an almost continuous cereal zone, the two extremities furnish a northern and southern pastoral region, in which a resemblance in geology (and therefore in soil), in physical outline (and therefore in climate), overrules to some extent the difference of latitude.

The contrasts offered by our social and national institutions, as influenced by law, custom, or art, likewise furnish many aids for reflection and incitements to action. We may, therefore, naturally hope to learn something from our neighbours. But further, a very slight survey of the state of France will lead us to expect that there really *is* much to be learnt there.

Many events have combined to foster French agriculture. The Empire rests upon the rural franchises, and is not unmindful of its origin or ungrateful. The Emperor has had almost an English training, and has as much energy and more power than any farmer among us; his courtiers naturally follow his steps; the statesman has felt the inconvenience of "Paris being France;" whilst the defeated of all parties retire to their homes, where, if they cherish resentment, they likewise cherish their dependents and lands, the one feeling probably waning as the other interest grows upon them.

The French law for the distribution of landed property, though it has thrown many an obstacle in the way of improvement, seems now to have received a check, which, however unsatisfactory to the moralist, proves on the whole conducive to agricultural progress, the subdivision of land being practically arrested at a point which leaves many estates sufficiently large to afford a field for the energies of the gentleman or yeoman owner, who is content with a modest competence unattended with anxieties for the future. Moreover in France, as among ourselves, men who have made large and successful ventures in trade, in railways,

or in the money-market, like to cast an anchor on terra-firma, and carry with them their dash, their enlarged range of view, and their command of capital.

Thus many agencies tend to the rapid development of French agriculture. Many motives also induce us to note our neighbours' progress: free competition, generous emulation (the happier form of national rivalry), the satisfaction of observing the leaves they have taken out of our book, the hope of gleanings something from theirs. Nor is this interest confined to our agricultural community, for other classes are equally interested in our supplies and the demands to be set against them.

If, then, we have every reason to look for agricultural progress in France and to note its steps with care, perhaps a review of some of the latest awards of the grand prizes (*les Primes d'Honneur*) given by Government for the best and most improved farms, may be a good means of gaining an insight into this subject. The French Government contributes to the encouragement of agriculture by paying a salary to the members of the Imperial and Central Society of Agriculture, by giving prizes and medals for stock and implements annually in the twelve districts into which the country is divided; and by giving a prize of 200*l.* in money, and a silver cup worth 120*l.*, to the owner of the best farm in one of the six or seven departments contained in each of these twelve districts, besides very considerably assigning medals and smaller gratuities to the manager and faithful servants on the prize farm.

The sum total thus expended in 1861 for prizes, &c., is as follows:—

	Money.	Number of Prizes and Medals.
For cattle*	£16,167	1274
„ sheep	8,429	403
„ pigs	1,456	250
„ poultry	212	187
„ implements .. ..	..	2422
„ farm produce .. ..	..	204
Prizes for farms and their attendants	4,320	180
	<u>£25,584</u>	<u>4920</u>

The prizes offered for horses are not included in this list, because they have special shows and prizes assigned to them.

The “Prime d'Honneur,” or Farm Prize, is thus announced:

“For the best managed farm on which the most useful improvements have been introduced.”

* It is worthy of remark that of this sum £2616 is bestowed on pure-bred short-horns, and £1808 on short-horn crosses.

It may be said that such a prize must be a very great attraction ; but is it a healthy, and is it a general one ? Is the prize within the reach of any but those highly favoured by soil, by wealth, by early training ? To such natural misgivings the awards seem to afford very satisfactory and conclusive replies ; now crowning the head of the capitalist who has worked wonders in a short time with great *éclat*, much benefit to his neighbourhood, and no inconsiderable outlay ; then covering the bald temples of a gentleman who has economically and unobtrusively pursued a long career of gradual advancement ; here recognising the skill and perseverance of an agriculturist who began life with these endowments for his whole stock in trade, there drawing from his retreat the energetic soldier of the old Empire, who has since been campaigning on a modest scale ; now showing how the man whose free spirit fretted and chafed against the trammels imposed on thought and action, grappled successfully with the elements ; then placing in the first rank of agriculturists the sailor, who, in a fit of enthusiasm at the preaching of a Dombasle or a Royer, turned—shall we say?—his anchor into a plough, took to him a wife, reared eight children for the state, and provided adequately for them all.

As the mass of materials available for our purpose is greater than can fairly be reproduced within the limits of a single article, it will be better to give a selection rather than an abstract ; some of the more memorable contests, or most characteristic groups, being chosen for description.

Let us first turn to the department of the Lower Seine—part of Normandy—giving it the preference not only from its resemblance to England, but because the jury (including two Norman prizemen) report that of the five contests held in that province this has been the most distinguished. Here, then, we shall see what our neighbours consider good farming under circumstances like our own.

For this contest twenty competitors sent in their names, of whom nine did not satisfactorily fulfil the preliminary conditions. The pretensions of the tenth did not bear a comparison with the rest, though he had increased his crop of wheat 75 per cent. ; that of oats, 50 per cent. ; and his yield of rapeseed eightfold. He was an adherent of the old three-course and bare fallow. The field as it then stood was nearly equally divided between proprietors and rentpaying farmers, and of the former one only appears to be a man of rank.

One farmer, M. Basset, showed that on 144 acres he had doubled his live stock in ten years ; the increase of his green crop being due to very liberal dressings of marl, lime, gypsum, nightsoil, and street-scrapings. He received a commendation.

Next, M. Burel, also a farmer, holding 284 acres since 1844, proved that in the interval he had increased his farm capital from 2400*l.* to 6000*l.*; laid down 32 acres in pasture, which he manures every third year with 50 cubic yards of compost, 6 cwts. of guano, and 4 cwts. of gypsum per acre; that he winters a grazing flock of 520 half-bred merinos, keeps pure and half-bred short-horns, good milkers, and fattens their produce. He had the same response—a commendation.

The Count de Malartic, who owns half the old family property which once surrounded the château, claims attention for the beet-root distillery, which he set up on Le Play's system, and supplies from his own farm of 230 acres arable, by the aid of a magnificent root store, holding 2000 tons, his usual crop.* To meet this demand for beet an eight-course rotation has been adopted, including of beet, 3 crops; of wheat, 2; oats, 2; clover,¹1. It appears that the beet, though so often repeated, averages 24 tons per acre. The farm is paid as high as 16*s.* per ton for all the beet delivered, and still the distillery makes a good profit. A splendid double shed has been erected for feeding cattle with the pulp.

"The jury, well knowing the services rendered by such distilleries to the agriculture of the North, by increasing the supply of butchers' meat and providing such a stock of manure as much advances the fertility of the soil, publicly thank this large proprietor for such an application of his fortune, which appears to have been made with strict regard to economy, and to have produced pecuniary results which are highly satisfactory. Such an example deserves to meet with many imitators."

Let us now look to the achievements of a proprietor of more moderate means—M. Dubosc—who farms 114 acres near Fécamp, which he bought nine years before the contest. We here meet with the spirited breeder (on a small scale) of choice animals; stock here occupy the first, not the second place. The soil is good, the subsoil strong, but not impermeable; and chalk and marl have been raised from a depth of 38 yards.

This spirited agriculturist keeps three short-horn bulls; one of them, "the Son of Baltic," is paid 1*l.* a cow by his neighbours; the three earn him 68*l.* a year. He keeps 6 good cows; one of them (7-8ths of short-horn) gives 17 quarts of milk per day. He has a stallion and some good mares (Norman and Cauchois). The breeding flock consists of 100 pure merino ewes and 100 possessing much merino blood; 7 pure merino rams are kept. This practical man has a manure dépôt, 80 feet long and 24 feet

* The floor of this store is five feet underground; it is traversed by a rail for a handtruck, and covered with tiles.

wide, with drainage and pump complete. He has also a spacious airy sheep-stall (*bergerie*), in four compartments, with a rack specially devised to keep the dust out of the animal's eyes. The *bergerie* seems almost universal in France; if only an adjunct of the merino race, will it hold its own? In 1851, M. Dubosc's farm capital was 1440*l.*; in 1860, 2000*l.*; he clears about 200*l.* a year above his expenses. A very pleasant picture this of energy, prosperity, and progress in a quiet way.

The next claimant on our attention is M. Aubry, who, as tenant, has had a shallow, poor, cold, clay soil to contend with on 242 acres, of which 200 are arable, 7½ acres being in sea-rush. By aid of composts his crops—wheat, flax, tares, peas—are reported to be superb, and his rapeseed to promise a yield of 38 bushels per acre. The flock called forth special praise—240 ewes (Cauchoises) put to choice rams, and other sheep to make up 600 head! The cow stock amounted to 30 head, a cross of short-horn. Of the eight dairy cows one gave 23 quarts, another 16 quarts per day.

On the next farm—that of M. Papin (215 acres)—beet, grown as an industrial crop, again calls for attention. M. Papin claims to be the originator in those parts of mangold culture on a large scale, and the use of its pulp for fattening stock.

In 1852, when M. Langlet, a sugar-refiner at Rouen, wished to start a distillery, and for that end to contract for a supply of 2000 tons of beet, M. Papin (his brothers aiding him) had the hardihood to take the contract. He then went to "the North" to study beet-culture, and persuaded his neighbours to be guided by him, to adopt his views, and grow this root, himself aiding their efforts by his advice and by a staff of from 150 to 200 workmen employed to cultivate and cart the crop. The notion that wheat would not do well after beet gradually disappeared, and the pulp became appreciated as cattle-food. By the use of lime and of English seed he has doubled his wheat-crops, and the produce of his meadows has likewise been doubled. The status of himself and his predecessor is thus contrasted:—

	New Inventory.	Old Inventory.
Cow stock	30	6
Horses	13	8
Ewes	220	150
Lambs	200	140
Wheat crop in sheaves ..	24,000	14,000
Oat crop in sheaves ..	7,000	5,000
Rape-seed	13½ bush. (?)	6½ bush.
Mangold	150 tons	0

M. Papin's services were held to deserve special recognition, but we are not yet in the front rank of the race.

The jury's perplexities only begin with the next aspirant,

M. Lange, since 1846 owner of 242 acres near Fauville, where we are again near the sea, and shelter-belts of trees and sea-rushes are again to be deducted from the farm proper.

This small tenant-farmer has erected a distillery, and supplies it himself with roots. To accomplish this, his rotation (praised for being truly "alternate") is as follows:—

1. Beet, well manured.
2. Oats.
3. Clover.
4. Wheat, manured with rape-cake.
5. One-half mangold, the rest trifolium.
6. One-half rape-seed, with a strong fold; half mangold.
7. Wheat, folded or lightly manured.

The 5th and 6th years are modified for the supply of mangold, that he may be independent of the market. To bear these crops 1-18th to 1-16th of the farm is marled every year; the clover is dressed with gypsum to very good effect; compost-heaps with lime are formed; the manure is carefully and scientifically made; the cultivation is very good. Howard and Valcourt's harrows, Crosskill's clodcrusher, Smith's drill, and a weighbridge, figure among the implements. The crops, which are reported quite magnificent and thoroughly clean, are set—the wheat at 33 to 38 bushels; oats 55 bushels; rape-seed (1860) nearly 42 bushels; mangold 20 tons on the average.

The live stock consist of—

Cows (short-horn cross)	..	..	..	6
Bullocks ditto	..	..	..	12
Young stock	..	..	..	14
Horses (picked mares)	..	..	..	14
Ewes, Chaulois-Merino	..	..	..	220
Hoggetts	..	..	..	70
Fatting sheep	..	..	..	130
Rams	..	..	..	4

M. Lange is shareholder in a company which buys prime short-horn bulls for joint use, and has won the first prize at Rouen with a fat ox sold for 56*l*.

The distillery cost for the buildings (simple but solid) and the plant together 800*l*.; "much economy must have been shown not to exceed this moderate sum." La Play's system is adopted: 22 gallons of spirit (100° French standard) are commonly extracted from 2 tons of beet; but in 1860 3½ cwt. more were required.

The rent of this farm, when let, was 280*l*.; the average net profit, since the owner took it in hand, has been 336*l*.; "that is to say, the net produce has been more than doubled." The inventory of December 31st, 1859, showed a farm-capital of

4119*l.*, or 17*l.* per acre. The total value of the produce was, in 1848, 1858*l.*, or 8*l.* per acre *under cultivation*; in 1858, 3231*l.*, or 14*l.* per acre.

These results were clearly set forth in accounts, a model for accuracy and distinctness of details, kept by Madame Lange. No wonder that the jury thought that here the prize was well earned, but they could not here bestow it.

We pass on to a farm, part of the large landed estate of Cany, held conjointly by Madame Rocquigny, a widow, and her two sons. This farm appears on the "Cadastre," or national register of land, to comprise 350 acres; but, after deducting some 50 acres for woods, 25 for waste, a large sandpit, roads, &c., 242 acres only remain for the farm, of which one-half of the soil, being both light and cold, is *rated* in the third and fourth classes. The further end of the farm—a blowing sand on an impervious clay—was left as a sheep-walk by the former tenant. It has since been limed and marled, and made into good pasture. The crops were clean and very surprising when the quality of the land is considered: wheat (English white-chaff red) 33 bushels on bad land; oats, tares, clover, beet, all very fine.

Manure and compost had done their work. In one year 335 cubic yards of perfectly-decayed vegetable compost had been applied to two fields (Nos. 29 and 36).

The present tenants found on entry a stock of manure of 222 tons. In 1859, there was produced upon the farm 1245 tons 17 cwt., exclusive of dressings, such as marl, lime, "sel de coussin," ashes, gypsum, soot, on which 517*l.* was expended in five years. After contracting to buy all the grains of a brewery at 5*d.* per bushel, these spirited tenants, knowing the value of beet-pulp for stock, determined to set up a distillery, buildings, stores, and all. It works up 4 tons of beet per day, thus supplying such a quantity of pulp as the stock can easily consume while it is fresh, so that they like it better and thrive faster. At the end of the season, when corn is cheap, that too is bought and distilled, the refuse being eaten with still greater relish by the animals. The live stock, of course, increased with the supply of pulp. The dairy-cows, "Cotentines," seem to be very good milkers, giving 17 to 22 quarts per day. They are put to a short-horn bull, belonging to an association in which the tenants have a share.

Some of the ewes (Cauchoises) have been put to a Southdown ram, which the landlord generously imported for the good of his tenants. The cross is thoroughly successful. The produce are much nearer to the ground, and better framed. For early maturity and diminished consumption of food to obtain a given weight of carcase, the benefit of this cross is very great.

Here again we are told, "The books of these gentlemen are perfect: not a detail escapes them. They draw up an exact account of each of the successive operations of their system. They have first a cash-book and a great ledger very regularly kept, then a labour-book, and an auxiliary record based upon plans (*établi en tableaux*)".*

To lighten their task they have distributed the arable land into 36 plots, duly numbered, which follow the natural divisions of the country; the homestead, grove, &c., have also each their proper number assigned to them. To each entry in the cash or labour-book a number is appended which refers that outlay to its proper object; when the great ledger is made up, the task is thus much facilitated. Each week the totals are cast and entered in columns in a special book, from which the totals are easily obtained at the year's end. The inventory is then drawn up; not only is a general account of the crops made out from these particular records, but the distillery, the flock, the dairy, the manure-store, have each their separate account, which the jury examined with the most lively interest.

These books show that "in the five first years of their tenancy, Messrs. Rocquigny have made profits amounting to 1943*l.* or 388*l.* per annum on 242 acres." I have quoted the preceding passage in detail, because it speaks not of the books of the model-farm or college—not those of the farm-manager, whose time is his employer's, and who, if wise, will be anxious not only to do right, but to show in black and white that he has managed faithfully and well—but the practice of a tenant-farmer.

Here, as in a previous instance of well-kept books, a lady's name figures; not as assistant, but as head of the firm. It may be questioned whether both in town and country, women do not now play a more important part in the management of accounts in France than in England; indeed, the passing traveller hardly fails to see signs of this in the shop, or the hotel. Many passages in the records which I quote speak in most flattering terms of the energy with which the modern Frenchwoman,

* If I rightly understand this expression, it represents a method similar to that adopted by Mr. Jonas in Cambridgeshire. That gentleman keeps the plan of each field on a separate page in an interleaved map-book; on the other side the culture, cropping, and produce for a series of years are neatly and concisely recorded. Thus, at a glance, a most instructive retrospect can be taken. For open fields with but few natural divisions this plan has special advantages, because the same field is often variously subdivided among different kindred crops; and a measurement, duly recorded on the plan, is the sole abiding record of the line of demarcation. These are agricultural statistics, the use of which will not be gainsaid. When, through such farm-accounts, farmers have become familiar with the use of these records to the *individual*, they will probably become sensible of the service which records, resting on a broader basis, render to the *community at large*, and so to each member thereof.

even a Parisian, throws herself into her husband's rural pursuits. The satisfaction and enjoyment, even the social consideration to be derived from being thus associated with pursuits which must engross much of the husband's time and thoughts, are well set forth in those pages. Allusions are also made to town misses, who come back from school only to hate the farm, and a call is made for more fitting and serious education, which may mould the intellect after a higher and more healthy fashion. Such a demand is in no way at variance with the cultivation of those lighter tastes and accomplishments of which the standard is ever varying with increasing civilization and wealth. A word on this subject is not unseasonable, when so much stir is being made about the education of young men: if it tend to the adoption of an improved method of keeping accounts, an important defect will have been remedied.

But to return to Messrs. Rocquigny,—besides these remarkable agricultural results, the jury were moved, both by the pleasant picture of confidence subsisting between landlord and tenant, and that of family devotion and union—each a necessary preliminary for such success—to let the prize rest here; but a still stronger claimant remained.

Who then eclipsed all these rivals?—A M. Dargent, of Reneville, near Saint-Léonard, who, at nine years of age, was left an orphan, and at twenty determined himself to occupy the little farm of the family (126 acres), that he might keep together and maintain his three brothers and sisters, who had no one but him to look to for support. Of this small property, 12½ acres were in sea-rushes, in roads, and shelter-belts against strong gales; of the pasture, if part was good, the rest was but a sheepwalk on the cliffs; of the arable (77 acres), only 6½ acres were rated in the first class, and 19 acres in the second (both these had a clay subsoil); the rest were third and fourth-class lands. The events referred to occurred fifty years ago; since then the buildings, such as survived the revolutionary period and an uninspected tenancy, have been completely renewed; and are now models of simplicity, solidity, and fitness. The jury state “much as we admired the crops of Messrs. Lange and Rocquigny, we must admit that those of M. Dargent were much superior to them, and so luxuriant as fully to justify the statements entered in the account-books. We estimated the first cut of the clover-crop, which we saw growing, at 2 tons 7 cwt. per acre.” The wheat-crop is stated to average 360 sheaves, and to yield 42 bushels of corn, weighing 1 ton 4 cwt. (nearly 64 lbs. per bushel); in 1854, it averaged 50 bushels. The oat-crop averages 320 sheaves, and 57 bushels of corn, weighing 18 cwt. 3 qrs. per acre. The rape-seed, 44 bushels (21½ cwt.) “The

beet-crop, 2500 hectolitres, weighs 150,000 kilogrammes; in 1857, they weighed 167,000, a fact recorded in a Report to the Society of Agriculture.* Until the disease came, M. Dargent grew 440 bushels of potatoes per acre. After trying many varieties of seed-wheat, French and English, he keeps to "the red wheat, there called Scotch," finding that the straw, which is short, but stiff and strong, best resists the gales which are so formidable at Saint-Léonard. In the rainy season of 1816 M. Dargent had the good fortune to save his crop (fielded till October), by being the first to set his sheaves in shocks, after the example of Madame Chevalier, his grandmother.

Since 1815 he has grown beet, swedes, turnips (*la rave d'Auvergne et du Poitou*), carrots; but soon found that beet was best suited to his farm. To him the department was indebted for its first factory for beet-sugar set up at Fécamp in 1831, since he undertook to provide the principal supply of beet; he introduced the *trifolium incarnatum*—the use of lesser and larger cocks in hay-making—and in 1832, made improvements in the horse-hoe, similar to those introduced in the most complete modern English implement.

M. Dargent has applied the same skill and judgment to his cider-orchard as to his farm; discovering varieties of apples which escape the ravages of insects, he regrafted all his trees with those sorts. In planting young trees, he applies manure, but only to the extremities of the roots.

His dairy-cows, which since 1836 have had a judicious cross of short-horn blood, are admirable. "It is difficult to find cows with better developed chests and ribs, more deep and more compact; and yet one of them gives 30 quarts, her daughter 24½ quarts, and two others 23 and 22 quarts apiece; while their condition shows how very easy it would be to fatten them for the butcher." From the first M. Dargent has picketed his cows both in the orchard and on the layer. He sells his milk at Fécamp for a little more than 1d. per quart, and considers that each cow gives him a clear yearly profit of 6l.

The flock at Saint-Léonard has long been famous; in 1835, and again in 1843, reports on its merits were printed; and the latter report gained for M. Dargent the Cross of the Legion of Honour. The stock—merino—was originally procured by M. Dargent's father from the Royal farm at Rambouillet, fell into the hands of his maternal uncle, and was brought back in 1811; since which time it has been improved and maintained with the

* This statement respecting the specific gravity of the mangold is one which the reporter says he would not have ventured to make on a less authority than that referred to. Its significance depends on the hectolitre being more accurately measured than is commonly the case with our bushel.

utmost pains. The wool is not quite so fine as in some flocks, but has a long staple. In form this flock surpasses its rivals; "no pure merinos are more close to the ground, straight in the back, or have better loins and quarters." Their fleeces weigh $4\frac{1}{2}$ lbs. (nearly), and have been sold at 2s. 4d. per lb. The flock, including 80 lambs, consists of 340 head. They show a clear profit of 85l. 10s. a-year, or 6s. 7d. per head. Five good cart mares are kept.

A farm managed with so much prudence, intelligence, and perseverance, could hardly fail to show a good balance-sheet. The following facts are gathered from the books:—

	£.
The farm at Reneville was let in 1794 for	56
And again let from 1800 to 1811 (a time of high prices) for	96
Mr. Dargent values the farm when he took it at	2880
(A liberal allowance, for land was then hardly worth 30 years' purchase.)	
The stock he took was valued at	1200
Making a total of	4080
There were charges on the property of	1760
Which left a clear capital of	2320

The jury when examining the books found that, for the thirteen years from 1846 to 1859, the profits amounted to 3175l., or 241l. on the average. The three last years showed a higher average of 252l.

	£.
Mr. Dargent thinks he may fairly value the estate at ..	6800
The stock, as by inventory, at	2320
He had in bank or invested in 1859	2495
He had paid for exemption from military service (!) ..	777
For dower for his nieces	2400
For purchase of land	160

His capital had therefore increased from .. £2320 to 14,952

Thus after weathering several storms—the destruction of his buildings by fire—the failure of the sugar-mill with which he was connected—the conscriptions—M. Dargent has attained his aim, never diverted from it but for a while in old times to serve in the "Cohorts," and again at the critical period of 1848, when the discrimination of his fellow-citizens constrained him to exhibit his good sense, modesty, and integrity in the General Assembly. The jury, when comparing M. Dargent's performances with those of his competitors, find he has done more than they, better than they, sooner than they; his younger rivals may then well make way for this "Master of Practical Agriculture." The jury, in fine, suggest to the Emperor's Government a course which exceeds their own

powers, viz.:—"That M. Dargent be promoted to the rank of Officer in the Legion of Honour, of which he has been for eighteen years a Companion; that M. Lange be made a Companion of the Legion. That the prize and the cup be assigned to Madame Rocquigny and her sons." But their *award* is—the prize to M. Dargent; and gold medals to Messrs. Rocquigny, for their accounts and their distillery; to M. Lange, for his excellent rotation, which is productive of increasing fertility, and for his drill husbandry; to M. Papin, as the introducer of beet-culture on a large scale; to M. Aubry, for the improvements effected in his flock by judicious cross-breeding; to M. Dubosc, for his buildings, and the service rendered to cattle breeders by his excellent bulls; to Count Malartic, for his good example in erecting a distillery, his drill husbandry, his Atkin's reaper, and good threshing-machines; to M. Burel, for his improved cow-houses; to M. Basset, for his zeal in introducing the drill, for his buildings, and the good management of his manure.

This account has run to some length; but if more compressed it would hardly have shown either the working of this magnificent prize under favourable circumstances, or the condition of agriculture in a thriving but not a pre-eminent district. The manner in which it brought into notice and rewarded modest, persevering worth, cannot but be hailed with extreme satisfaction by all the friends of the genuine farmer.

THE LOIRET.

Let us next take a glance at the contest of the Loiret, where we shall find the race nearly reduced to a match between two gentlemen of good property and of great distinction as agriculturists. The improvement of wastes by plantations on a large scale is here exhibited alongside of the valuable industrial crops which test and tax the fertility of the rich alluvial lands bordering on the Loire: yet in the background we have "the Sologne," a name suggestive of all the ills attendant on poor, cold, wet, isolated districts of sand and clay.

Of the farm of Chenaille, the property of M. Bobee, who ran a very good second, we have no detailed report. The property is large, 4500 acres. A completely new face has been put upon that and adjoining estates by M. Bobee's example during forty years. The miserable *métayer*, or half-holder,* who had to be supplied with stock is superseded by a tenantry holding leases of eighteen

* The name *métayer* is hardly familiar to all readers; it applies to an occupier who is supplied with chief part of the stock, live and dead, on condition of rendering to the landlord half the produce. The English word "half-holder" will suggest its own import.

years, renewed at much increased rents; yet this change has been very quietly effected, and the owner modestly reports, "You will not find anything very new or very remarkable on my farm in the way either of buildings, stock, or crops." Indeed, the implements still in use are in the main such as were adopted and improved upon in 1826. This farming is evidently no flash in the pan; there may be much light though little smoke about it.

But we must pass on to the winner, M. de Behague, and his farm of Dampierre. The Home-farm of 1042 acres is part of a considerable estate, the survey of which shows we have entered a new field of management. It contains of—

	Acres.
Old woods, deciduous trees	986
Young woods	810
Fir plantations	1195
Arable land	952
Meadow	156
Other pastures	53
Ponds and reservoirs (!)	330
Wastes, roads, and gardens	190
	<hr/>
	4672

Since 1826 M. de Behague has applied himself with great energy to the improvement of his property. His career is remarkable, because in his practice are combined the lessons of two almost antagonistic schools of modern French agriculture, those of M. Dombasle of Roville, and of M. Royer. The former proclaimed, "Away with the bare fallow and scourging succession of corn crops! Practise alternate husbandry, deep culture, and the growth of roots and forage, with the same yield of corn as before on half the area. In short, high farming and the maximum of produce."

The other had for his motto, "The net produce—the clear profit;" and he taught, "No uniformity! Cut your coat to your cloth; be regulated by soil, climate, markets, command of capital; do not force some patches with high farming, and leave a wilderness around them; do not rob Peter to pay Paul." Land has its natural stages of existence, its "*périodes*," according to the state of civilization and progress around. This estate is at the forest epoch; another at that of sheep-walks and cattle-runs (*période pacagère*); a third at that of alternate husbandry and stall-feeding (*période fourragère*); a fourth at the corn-growing point (*période céréale*), because, without danger of exhaustion, more than half the land may be devoted to cereal crops; and finally the Commercial Epoch (*période commerciale*) is attained, when *industrial crops* (such as provide the material for factories) can be profitably grown to a considerable extent.

The period of irrigation should perhaps be added to this series, which will work a greater change in our supply of forage than alternate husbandry has effected, whenever we can shake off the trammels of custom, the conflict of private rights, and the obstacles imposed by legal embarrassments.

It was M. de Behague's fortune to be at once the pupil of M. Dombasle at Roville, and the neighbour and friend of M. Royer; and thus, while he became popularly known as the exhibitor of high-bred stock and a pattern for high farming, he chiefly prided himself on being a sound rural economist, and pointed with especial satisfaction to his woods waving over Moque-gueule (Baulk-throat), once a dreary tract, where to the far horizon no sign of vegetation or of man was perceptible. The estate, then, contains specimens of land of all kinds, worth from 70*l.* per acre on the banks of the Loire, to 3*l.* in the back country; and the management and capital employed vary with the soil. Here 16*l.* per acre is invested, and a bullock or its equivalent in live stock * kept on every hectare (2½ acres); there the outlay is 15*s.*, and the crop, fir-trees.

In 1826 M. de Behague found that part of his estate which is called Dampierre, 1440 acres in all, divided into sixteen holdings, which together paid 362*l.* a-year. Of these lands the 1040 acres (arable and grass), now included in the farm, are charged with a rent of 682*l.*, and the yearly increase in the value of the plantations which he has made, is set at about 8*s.* per acre, or 150*l.* a-year for 380 acres. At that time the corn grown hardly sufficed for home consumption; the live stock were few and wretched, fed on the waste, to the injury of the woods, which were maltreated in every way. The course pursued was to select the best lands for culture and plant the rest, doing justice to both.

The farm consists of portions varying in extent and quality:—

	Acres.
The Hill Farm contains	470 arable
The Valley Farm	170 „
The Chenoy Farm	100 „
	<hr/> 740
To which must be added—	
Sheep-walk, often flooded by the Loire	150
Pastures, chiefly recently laid down	155
Paddocks, &c.	50
	<hr/> 1095.†

The soil being chiefly a mixture of sand and clay, devoid of lime, with an impermeable wet subsoil of tufa, these lands were

* In France, 10 sheep or 5 pigs are considered as equivalent to one bullock or horse.

† This total seems to include some small additions to the original purchase.

scorched in summer and soaked with wet in winter, until drainage, marl, lime, and deep ploughing, have changed their aspect. The rotations introduced are all characteristic of good modern farming.

The history of the flock presents certain special features. Merinos were first substituted for the native Sologne race; but when fine wool fell and meat advanced in price, a cross of Leicester blood was tried. Finally the Berri breed was introduced and crossed with Southdown rams. At first all the cross-bred sheep went to the butcher; but experience soon showed that it was as easy to keep the half-bred ewe as the pure native race: both are, therefore, now kept, with about fifty choice Southdowns, which, as well as the cross-breeds, have won many prizes. On the three farms 1900 sheep are kept, of which 900 are folded on the land all the year round—a practice comparatively rare in France. The wethers fetch 33s. at thirty months' old. The ewes bear three lambs and are then fattened.

The stock of cattle consists of 16 short-horns—which have often received prizes at Poissy, Orleans, &c.—48 others of Charolais or half-bred, and 40 working oxen. The choice stock are weighed every month, and a careful register of their progress is kept, which has thrown much light on their management.

M. de Behague is a strong advocate for the employment of bullocks of a hardy sort for draught, and recommends that they be worked only half a day. He prefers the Limousin breed.

The list of implements includes most of our first-class English inventions; much pains have been bestowed on the farm-buildings, which have been rebuilt with equal attention to economy and convenience: moreover it is reported that, "*Of course* a still more lively solicitude has been displayed in the sanatory arrangements of the dwellings assigned to all the persons employed on the estate." The clay hovels with earthen floors, low, damp, devoid of air or light, which characterized the Sologne, have disappeared. A quarry which was discovered, and tileries which have been erected on the property, have contributed to this change, and the example is not lost on the neighbourhood.

M. Behague's influence has also introduced the culture of Jerusalem-artichokes, maize, winter tares, trifolium incarnatum, sorghum, yellow lupines; and substituted the growth of wheat for that of rye; the best test of such improvements being that the value of land is tripled in the neighbourhood.

The supply of labourers seems to be in a deplorable condition in this district. Farm-servants generally change their places twice a year; various circumstances conducing to this end, such as the objection of masters to married servants, and the predilection of the servants for the "Letting," or Statute Fair; the

only incident that breaks the monotony of their hard, dull existence. Such a custom is fatal not only to mutual attachment between master and man, but also to the acquirement of skill in the use of improved implements.

M. de Behaue has overcome this unkindly practice, and is justly proud of having attached to himself and his farm, foremen of 33, 13, and 10 years of service; carters claiming 21 and 13 years; cowmen 15 and 12 years; shepherds 18 and 10 years, &c., &c.

One singular feature in this estate must not be passed over—the ponds or lakes (*Etangs*)—the bane of the Sologne. We have seen that 330 acres of the estate were thus covered with water.

One valley contained a succession of four such pools: the first, measuring 175 acres, is of service for water supply and water power, the fourth also acts as reservoir and watercourse for the chief mill, but the second and third have been abolished. This has been effected by cutting a canal in the hillside, which not only delivers the water from the first pool directly into the mill-head, but draws off the soak from the second and third ponds, and the drainage waters from the adjoining lands; 30 acres of good meadow have thus been gained by an outlay of 300*l*.

In 1857 more than 3000 cubic yards of pond-mud were taken from a pool which receives the drains of a village, and were spread on the adjacent pasture. The effect was such that the grass crop was lodged, and could not be cut by the mowing machine, and the mowers could barely cut 3 roods a day.

In this, as in other cases, the Report is concluded by a financial statement taken from the account-books, which since 1839 have been very exactly kept by double entry.

Since that date the farm has been charged with a rent of 682*l*., which could not readily be obtained from a farmer; the general expenses are also very large—556*l* yearly—an amount which the style of living and hospitality of a wealthy proprietor alone explains. Notwithstanding these charges the balance of the farm accounts is generally on the right side, but the real profit of the estate turns mainly on the fertility and wealth that is being gradually accumulated.

The price paid for the estate by M. de Behaue in 1826	£.
was	25,520
The contingent expenses came to	2,486
Between 1826 and 1839 there was expended on new purchases of land, on building and furnishing a château, enclosing commons, planting and replanting 1700 acres of woods, reconstructing farm buildings, draining and marling, forming embankment to the park, and purchase of stock	23,533
Making a total of	<u>56,489</u>

Since 1839, and up to 1859, the total outlay has reached ..	£. 59,349
Besides capital required for working the farm, &c.	9,880

Total investment	69,229
--------------------------	--------

In 1859 the inventory of live and dead stock, crops, forage, &c., came to	£. 10,610
To this we may join for outlay on château, park, and place	10,000

Together	20,610
Leaving for cost of the productive lands	48,619

The net receipts from the estate increase every year, the return on the average of the three last years in the account being 1330*l*. But this statement takes no notice of the young woods—2000 acres—which are as yet unproductive. If these are estimated at 8*s*. per acre for each year of growth, their annual value is 800*l*., which, added to 1330*l*., gives 2130*l*., or nearly 4½ per cent. on 48,000*l*.

“It should be remarked that the Dampierre estate pays only 210*l*. for taxes, a very low figure, consequent on the numerous plantations exempted from taxation, and on the fact that the last survey was made before most of the improvements had been effected.”

M. de Behague's merits as an agriculturist have been recognized by 106 prize medals, and three cups, by his appointment to be Member of the Imperial Society of Agriculture, Member of the General Board of Agriculture, and first, Member, then Officer, of the Legion of Honour; distinctions now crowned by the award of this splendid prize.

THE ARDENNES.

Let us now take a glance at a Northern district still less favourably circumstanced—that of the Ardennes on the Belgian frontier, part of the old Province of Champagne.

Of this department M. de Lavergne writes as follows: * “The Department of the Ardennes, which occupies the extreme north of the province, was once an unbroken forest, famous in the earliest antiquity and in the Middle Ages, of which many remains are still visible. It consists almost entirely of a series of lofty plains bearing the name, now known to fame, of the ‘Chain of the Argonne.’ On this schistous† soil the growth of every plant and animal is stunted (*rabourgrie*); nothing but the most skilful and stubborn culture can turn it to any good account.”

* ‘Economie Rurale de la France,’ p. 127.

† “Schistous,” consisting of schist, a “cleavable” rock readily reduced by atmospheric influences to a clay-earth. . .

He further goes on to show how that province, which early fell to the Crown, was especially oppressed with taxes, and then, again, devastated by revolutionary wars; so that, where capital was most indispensable and most hard to acquire, there the existing sources of wealth were most cruelly drained.

In the Report given of the competition, a more peculiar interest centres in some of the farms rewarded with the gold medal than in the large and spirited enterprise of the successful candidate, M. Gérard de Melcy, whose management turns on a beet-distillery, as a basis for the production of roots, stock, manure, and corn on moderately good land, such as might be met with elsewhere.

A farm of 1000 acres, of which 770 acres are arable, on which 2400*l.* has within the last ten or twelve years been judiciously expended on improvements—where the rotation is, corn, 360 acres; rape-seed and roots, 180 acres; lucerne, saintfoin, and clover, 180 acres; beans, 25 acres; fallow, 25 acres; where the inventory taken in 1860 exceeds that of 1849 by 4400*l.*—must ever command attention, and its well-kept accounts must advance the science of Rural Economy. From these we gather that “the erection of the beet-root distillery (on Champon’s principle) cost 604*l.*; that, with working expense of 13*d.* per day, the juice extracted from 5 tons 16 cwts. of beet (about 2100 gallons) is distilled; that the spirit produced amounts to from 5½ to 5½ per cent., or, in other words, that on the average 2 cwts. of beet produce 11½ gallons of pure alcohol (*alcool absolu*).

When we see what a mighty agent the introduction of beet as an *industrial crop* has proved for the regeneration of agriculture generally in the North of France, we may see reason to note and ponder such statistics in our minds, even if at present we cannot advantageously turn them to practical account.

But, as I have said, the distinctive interest here centres, not in the Winner, but in the Field, who all ran in nearly the same colours. They are proprietors of rather small farms, who, as a last resource, when their tenants were quite farmed out, took possession of the waste, and by energy rather than by capital put a new face upon it. These farms had many features in common, for it is well said in the Report, “the lineaments of wretchedness are uniform,” and many pictures of their former condition still exist around. A hungry soil, saturated with wet or harried and drowned by waters bursting down at random from the upper grounds till they subsided into pestilential pools; a subsoil of sticky yellow clay, mixed with stones that the farmer dare not bring to the surface; “roads—such roads!”—miserable hovels for buildings; fields abandoned in despair to scrub, furze,

and fern—because, even after grubbing and burning, the promise of a slender crop of rye was baulked by winter frosts—these were the leading features of the new take; with a few clumsy implements, some half-starved cattle, a short supply of the worst of stover—the bare bones of the outgoing tenant's substance—for a stock-in-trade. The best gauge of this penury will be found in the current price of the land to buy or hire. Mr. Maréchal Galle, one competitor, bought lands at an average price of 2*l.* 12*s.* per acre; “they are now classed amongst those for which the general price is 32*l.*” I give this *verbatim*, because this *classing* may imply *taxing*—a searching test of improved value. Or, again, the farm of M. Gossin, 220 acres, had been let for 40*l.*, and at the termination of the lease the tenant only offered 24*l.*, which was declined; in another instance the two last tenants *bolted*.

The course to be pursued was generally the same: first, drainage, arterial or field; then deep cultivation to break the face, such as “*Talpa*,” likewise a proprietor, depicts; then liming; then the careful collection of vegetable matter of all kinds for compost; when in time clover and roots followed corn, some accommodation for stock; and, lastly—to our shame, who have had so much better a start in a milder climate!—the application of the drainage waters from above to irrigation below.

This was a work specially adapted to proprietors of moderate means: they were constrained to make the best of that property which was their sole means of subsistence, whilst the nature of the work, the state of their finances, the hazardous question, “will it pay?”—all pointed to a commencement on a small scale; the economy of the process being tested by the growth of the means for its gradual development. A tenant would have hesitated to saddle himself with a tract of bad land, when he was only prepared to deal at first somewhat diffidently with a small part of it.

But if the position of the competitors was similar, their antecedents were various. In one instance the owner, M. Gossin, a public functionary, sent his two sons to the Agricultural College at Grignon, and then turned them loose on the farm, now comprising 350 acres, to bear the grins and gibes of their neighbours; till unremitting toil, intelligently applied, compensating for lack of capital and experience, won them their “footing,” and enrolled them among the farming celebrities of the country. One son is now a Professor of Agriculture, and he has been well schooled. The other holds the land; cultivates it with the improved implements which he saw at College; has laid dry the swamps; tile-drained much of the land, planting some parts that he might

concentrate his farming; made model roads; and last—not least—kept clear accounts, and “accounts are a necessary check, which never misleads.”

To M. Leroy a gold medal was assigned for improvements in drainage. He had one special difficulty to deal with, the choking of his pipes by a crust of oxide of iron, which he has met successfully by scouring out these drains from time to time by the agency of a rapid stream that runs down from above. He has laid 97,000 pipes on 72 acres, at an average cost of 3*l.* 15*s.*, all expenses included. He turns all the drainage-water to account; drainage and irrigation go hand in hand. After a tenure of ten years, his live-stock are worth 860*l.*; his grain, stover, and roots in hand, 280*l.*; implements, 180*l.*; making in all a capital of 2280*l.* on a farm of 225 acres, which the last tenant abandoned.

The claims of the two last competitors point to a more advanced stage of agriculture.

M. Therion, near Nanteuil, calls special attention to his farm buildings, and raises the question whether he is right to erect two homesteads for 450 acres of land. The award of a gold medal answers him in the affirmative. To us the most striking feature in his plans is, that he has sheep-stalls (*bergeries*) for 700 sheep!

Finally, M. Darodes de Tailly receives the gold medal, not only for reclaiming 50 acres of swamp, and protecting his hill-side farm from the ravages of the floods, but specially for his water-meadows, scientifically laid out on the Southern method, with dams, reservoirs, carriers, &c. It is remarked with dissatisfaction that one-sixth only of the meadows of the Ardennes is irrigated. What account could we render under this head—if, indeed, we could render any at all?

A contrast is drawn between the valuation of M. Darodes' farm of 141 acres (A.) and that of a neighbour, comprising 149 acres (B.) :—

	A.	B.
Live stock, reduced to the standard for large cattle	40	30
“ Mobilier Agricole ” (query, stock and crop?)	£622	£38
Dead stock	142	56

This contrast, it is pointedly stated, is due to the water-meadows.

AVEYRON.

Let us now plunge into the interior, to the Department of Aveyron, that we may see what may be accomplished even in France, and in a corner, by local institutions, without the intervention of the central Government, and also note some of the bickerings which now and then attend on the best of institutions,

checking their influence, and casting doubts on their awards. In this case the jury, warned by some earlier misadventures, gave no detailed report of the unsuccessful farms, in the vain hope of thus silencing objections. As a reward for this chariness, their award itself was much canvassed; whilst happily other reporters have been found to venture on a general survey and critique of the contest for the benefit of the public.

Aveyron is situated in the east of Guienne, to the south of Auvergne, and therefore on the southern slopes of those primitive rocks which there form a vast amphitheatre. It consists of two divisions, the Segala or Ryeland district, next to Auvergne, where the granitic rocks have crumbled into a clay soil full of mica-schist, abounding in silicates, and wanting in lime; and further south, that of Le Causse, a poor soil abounding in lime. From the nature of the soil, and from the climate, this region is ill adapted to corn-crops; though by liming and high-farming even the "Rye-land" district may be constrained to grow a fair yield of wheat; but when railroads are more developed, it is anticipated that grazing will still more extensively take the place of corn-growing, in which case irrigation rather than the root-crop will be the key of the system: and already Aveyron has something to teach us about irrigation.

This region seems to know little of the Farmer proper, but to be occupied by Half-holders, till the owners, weary of seeing everything go back while the world at large is advancing, take the land into their own hands. Population has here made little or no progress, so that a want of hands is felt as farming improves—a singular feature in an isolated agricultural district!

In Aveyron, in 1842, a local prize of 60*l.* was instituted, under the auspices of M. Guizard, the then prefect, to be annually awarded "to the proprietor who, at his own cost and risk, has by a considerable outlay promoted the experience, changes, or improvements judged to be most conducive to the progress of agriculture in the Department." This institution had prepared the way for the larger "Prime d'Honneur:" the elements for a good contest were at hand; the entries obviously consisted of the previous local winners, except where death and change of tenancy had narrowed the field. Unhappily the chalky district, Le Causse, thus lost its best representatives, the modesty of the son and successor preventing him from claiming a reward for work chiefly done by his father. The farms of the late General Tarare and M. Giron were thus excluded. It was then an agricultural Derby-day, with no dark horses; and the public were the more disappointed at being prevented from "assisting" more largely at the award, which, after a somewhat hasty inspection, seems to have been published with as little explanation as possible.

From M. Dissez's farm we may get a glimpse of the Half-holder's management; it is in "the Rye-lands," a granitic soil; the best fields were always in corn; the worst, after two corn-crops, lay fallow for four or five years. The small amount of stock kept did not furnish a dressing of more than 3 tons of manure per acre, when applied. (The supply of manure has been increased sixfold.) The rye-crop never exceeded 7 to 8 bushels per acre! The landlord's share of the proceeds was never worth more than 64*l*. Liming (160 to 200 bushels per acre) and deep cultivation, ample manuring up to 40 tons per acre for roots, and irrigation with water charged with lime, have so changed the farm that the old and new produce may be contrasted as follows:—

	Old Crops.	New Crops.
Wheat, per acre ..	.. none.	32 bushels.
Rye	7 to 8 bush.	24 "
Oats .. .. .	.. .. .	40 "
Barley .. .. .	.. .. .	40 "
Straw (average) ..	.. .. .	1 ton 8 cwts.
Pastures	as Hay	1 ton 12 cwts.
Clover and layers, tares, Stover ..	.. .. .	2 tons.
Green maize .. ..	.. .. .	12 "
Carrots .. .. .	.. .. .	20 "
Beet .. .. .	.. .. .	12 "
Turnips .. .. .	.. .. .	8 "
Potatoes .. .. .	.. .. .	7 tons 4 cwts.
Stock of Hay ..	40 tons	200 tons.

The value of the proceeds has risen from 64*l*. to 320*l*. or 360*l*. for the last five years.

M. Dissez has introduced short-horns into Aveyron, and possesses two bulls, three pure-bred and four half-bred cows; he has had New Kent and Southdown rams, and a New Leicester boar. His rotation, after liming the land, is—1st, roots heavily manured; 2nd, corn; 3rd, half clover, half tares or maize; 4th, corn: 175 acres are already under this treatment. The jury awarded him a gold medal for the perfection of his root-crops.

Baron Dufau has produced similar results—has increased the produce of wool 50 per cent.; grows more produce with less seed, raising 3000 bushels of potatoes from 137 of seed, instead of 1900 bushels from 150 bushels; keeps his own accounts by double entry. A gold medal was awarded to the Baron for his buildings.

M. Rodat, of Olemps, the third candidate, is the son and successor of the most distinguished farmer of Aveyron, the winner of the first local prize, which was awarded in 1841, who then based his pretensions on these grounds—1, the substitution of alternate husbandry for the three-course; 2, the introduction of improved implements into the district; 3, accounts kept by

double entry; 4, the improvement of wet lands by covered drains and deep cultivation; 5, irrigation and the conversion of dry into water-meadows; 6, grubbing, paring, and burning, combined with manuring. He might have added (it is said), the publication of the 'Cultivateur Aveyronais,' a model for agricultural literature. M. Rodat placed his son under M. Dombasle's training, at Roville. The son there learned how to make improved implements, and, on his return, established works which supplied to the neighbourhood more than 2000 ploughs, harrows, &c., at their cost price! The Dombasle plough—as famous in France as any of our English make—thus at once superseded the Roman "aratrum," which had till then held its ground; a like zeal for the public good prompted M. Rodat, Sen., to supply his neighbours gratuitously with the seeds of beet, carrots, &c.

M. Rodat, Jun., has introduced the new Kent rams for his flock; some of his sheep now weigh 2 cwt. when in store condition; the clip of wool weighs 11 cwt. instead of 8 cwt. He first fattened beasts on oilcake, with roots, and sells them as high as 80*l.* per pair. His corn is so clean and well dressed that it is mostly sold for seed. He has nearly doubled his supply of green food, and therefore doubled his number of large stock. His growth of corn is 1400 bushels (half wheat), instead of 950 bushels, chiefly rye. The gold medal was awarded to him for his flock and sheep stalls.

The next candidate, M. Rodat, of Druelle, belongs to the same family; his property (535 acres) is in the "Ryeland," with the exception of 55 acres of poor calcareous soil. His first task was to clear the gorse, fern, and rushes from lands *some of which were bought at 1*l.* per acre in 1806*; his next, by stone drains and irrigation, to conquer and utilise the waters; the third step, which gave full effect to his previous labour, was to burn his own lime so as to make his poor calcareous land a mine of wealth for the farm at large: he now applies water, recently saturated with quicklime, to his meadows with great effect, thereby destroying the worms (*les vers* *).

On this and other farms the chestnut woods, which of old contributed largely to the sustenance of the poor population, have been carefully set in order on the hill-sides, and modern hedges have been reared on the plain.

Of large stock, 133 head are now kept instead of 15; and the yield of oats or rye is ten times the seed; that of wheat five times the seed (this is significant). The income derived from the farm in 1853 was 120*l.*; it is now from 600*l.* to 640*l.* A gold medal

* If grub generally are here meant, the hint may be useful; if worms only, the benefit is doubtful.

was awarded to M. Rodat, of Druelle, for his drainage and irrigation.

We now come to a veteran of decided character, M. Durand, a good specimen of the practical man—which commonly means one who shrewdly adopts and perseveringly carries out certain views well suited to his position, entirely discarding from his mind all that does not readily fall in with those designs. Succeeding, in 1814, to a property which lay piecemeal, M. Durand shortly sold it to buy a compact farm, to which he has since added another; so that he now holds about 645 acres of variable soil. "From the first he clearly perceived and resolutely applied the doctrine—then a great novelty, now a popular truth—that Aveyron, which, from its mountainous surface, and its elevated position between two seas, has a very rainy climate, should make its farming hinge, not on corn, but on stock." His practice has been to break up his rough pastures, put them through a course of roots (potatoes, mangold, carrots, turnips, cabbage, maize) and corn (oats by preference), and then lay them down. Want of labourers has restricted his root-crops: at present one-third of the farm is in corn and potatoes; one-third in forage-crops; one-third in improved pasture.

M. Durand introduced the practice of liming on a large scale; his kilns have been at work these forty years; he has done much earth-carting to mix his soils. Dissatisfied with the practice of sending the cows in summer to distant mountains, he abandoned his dairy. The fear of the rot made him part with his breeding flock. It is his custom to give one very deep ploughing (10 to 12 inches), and to cover in the manure when fresh: repeated ploughing he considers to be exhausting. He grows the same amount of corn as before, on half the breadth of land; but was obliged to abandon the seed-drill from the wilfulness of his workmen.

M. Durand's great aim is to *simplify*; to this end he has cleared away walls and fences—has ceased to breed sheep or cattle. He has diminished the range of his hoed crops—has left off rearing horses, or even breeding pigs or poultry, that he might devote himself to grazing and growing corn. Hemp-growing and spinning has been abandoned; the accounts made so plain that, while he was in exile, his daughter readily managed his affairs for him; the staff of labourers, whose carelessness and incapacity he loudly denounces, reduced to a minimum (fifteen persons); so that, whilst his net income is lower on a given area than that of certain of his neighbours, his outgoings are one-third less. The live-stock of this farm used to be 20 head of cattle or horses and 300 sheep; now there are 100 cattle, 12 working-bullocks, 4 horses and mares, 300 grazing-sheep. The

growth of corn was formerly 1400, now 3300 bushels—the wheat yielding 18 bushels, barley 23 bushels, oats 27 bushels per acre.

During M. Durand's exile part of the farm was let for a time, and thus afforded a practical test of the improved value. Estimated on this basis, the income had increased from 240*l.* to 791*l.* per annum.

But I would now invite special attention to the chief work of this man of concentrated energy. *In spite of unheard-of obstacles raised by proprietors of adjacent lands and mills, and by the officers of Government, he turned a branch of the Aveyron river, constructing a stone weir, and forming a canal 3000 yards in length, which served to irrigate 75 acres with water often charged with warp; whilst the earth dug out of the canal formed a bank to protect 50 acres from floods. It took thirty years to master his opponents, and gain a legal right to use a fall of 13 feet and 30-horse power, by which the canal water is returned to the river.* M. Durand's personal experience prompted him to take up the general subject of irrigation by branch streams derived from rivers, which he has advocated in many publications; one of these, in 1831, received a prize offered by the Royal and Central Society of Agriculture for the best Essay on the Law of Irrigation. If our Society is precluded from offering a similar prize, we may perhaps glean some useful hints from this document.

He has received a gold medal for the diversion of the waters of the Aveyron. If any one should accomplish the same feat in England, a Victoria Medal or a statue in Trafalgar-square would hardly be excessive or unsuitable rewards!

M. Barascud next claims our attention as the owner of the 330 acres, of which 200 were, in 1849, entered in the Public Register (*Cadastre*) as waste, unsettled lands, and consequently nearly unproductive: prior to 1852 the farm was rented at 48*l.* The owner then found near Aveyron a good practical agriculturist, M. Ygrier, and installed him on the farm as Half-holder. The first object of these partners was to bring the waste under the plough. The surface furrowed by the torrents had to be levelled; the Dombasle plough, followed by a subsoiler, was then set to work, and a luxuriant crop of lucerne was the result; a fine crop of wheat followed; the flakes of schistose rock have since melted down under the combined influences of fresh manure, sun, and frost; and the land will now bear comparison with the best alluvial soils on the plain. This example, which was at first ridiculed, has since been followed on 50,000 acres of similar land, which were a blot upon the district of Cameres. The rest of the farm has been enriched by the diversion (in

concert with other proprietors) of the waters of the Dourdon, which are charged with good warp. The canal is $3\frac{1}{4}$ miles in length; after traversing two communes, it reaches this estate, where irrigation has substituted 5 crops of grass for 2 crops, and has doubled the bulk of each cutting, besides producing similar effects on the corn-crops.

Oak and ash have here been planted as a shade for the flock. The *garance* is successfully grown for dye; but this cropping is not taken up by the neighbourhood.

The stock of *draught* animals once consisted of 2 cows! it now includes 8 oxen, 2 horses. The other live-stock were formerly 80 ewes, 10 pigs; there are now 270 sheep, 4 goats, 2 cows, and 50 pigs. In 1852 the corn grown was 220 bushels; in 1860, 711 bushels. In 1852, 6 cwt. of cheese was made; in 1860, 127 cwt. The profits of the flock were, in 1850, 32*l.*; in 1860, 344*l.*

These two last items must probably be read together, for the cheese is probably sheep's-milk cheese (Rochefort). In the selection of the flock special reference is made in these parts to the milking properties of the ewes. The limestone grottoes in the neighbourhood are much prized, I am informed, as natural cheese-rooms.

The net income was, in 1852, 48*l.*; in 1860, 308*l.*, besides a stock of manure worth from 80*l.* to 100*l.* These results have been obtained by an outlay of only 240*l.* The object was, not dazzling, but steady improvement; it, therefore, finds many imitators.

A gold medal was awarded to M. Barascud for turning the waters of the Dourdon; to his Half-holder, M. Ygrier, for the perfection of his tillage, wrought to the depth of 23 inches by the Bonnet plough, which he brought with him from his little property, of $7\frac{1}{2}$ acres, near Avignon.

The prize farm, that of M. de Monseignat du Clusel, still remains to be considered, which seems to have been preferred for its *completeness* in regard to crops, live-stock, implements, buildings, and accounts, and the neatness and order which prevail in every department.

This farm of 390 acres, resting on a granitic subsoil, had been managed on the principle of extracting all that was to be had with the least possible outlay, until the owner took it in hand and soon tripled its produce, besides tripling the market value of much similar land around him from the influence of his example.

This land of furze, broom, fern, and rushes was once a perfect sieve for manure; but composts of lime and marl have wrought such a change that fields bought for 3*l.* per acre were in 1843 valued at 16*l.*

In 1832 M. de Monseignat, then fresh from Roville, took possession of the farm, in an utterly dilapidated and beggared state.

The best of the land then grew broom for five or six years, which was cut and burnt or sold, then stubbed and tilled for rye, followed by oats, without any manure, and then abandoned again to the broom. On the inferior lands occupied by gorse and fern, longer intervals were allowed. The first step was to clear, manure, and till the best lands, disregarding the objection that the flock would be starved, and then, as manure accumulated, to attack a fresh piece, and even devote a few chosen strips to mangold and carrots. The second and most important step was liming: about 4 cubic yards were applied to the acre on Pavis's plan, *i. e.* small heaps of quicklime are formed in the field, and immediately covered with a bed of earth 6 to 8 inches thick. When the lime has fallen into powder, both lime and earth are spread by the shovel as evenly as possible. The effect was marvellous; wheat supplanted rye, leguminous crops took their turn; the crops of high character were tripled; and so striking was the lesson conveyed that the whole districts of Segala adopted the practice of liming wherever the supply was within 50 miles. The lime carted to Clusel costs about 6*s.* 8*d.*, of which 3*s.* is for cartage. After a while M. de Monseignat extended his operations by the purchase of 150 acres, at the average price of 2*l.* per acre; an outlay of about 28*s.* for grubbing, paving, and burning, and spreading, often produced a crop which more than repaid for the whole investment—that is before the land market was spoiled.

The farm buildings have been quite remodelled, but primitive simplicity still survives in the use of a *cow-power* for working some cider and clover mills, &c.

The rotation, as far as possible, is: 1st year, hoed crops (potatoes, turnips, mangolds, carrots, swede turnips, rape, &c.; 2nd year, spring corn; 3rd year, clover; 4th year, winter corn; 5th year, fallow or an early forage crop. This last is the year for liming, deep cultivation, removal of rocks and stones and drainage. Forty acres are manured every year. The subsoil, here a detestable sand, there an impenetrable gneiss rock, requires both caution and strength for the work of subsoiling.

The drainage water has been turned to account for water meadows; neat reservoirs have been made, and fishbreeding carried out on a large scale; indeed, in the garden and grounds, art has contributed as much to the picturesque as to the more homely objects of the farm.

Since 12 or 14 working bullocks are kept besides the cows, which take their part in works of lighter draft, such as rolling,

harrowing, carriage of straw and fodder, &c., the Aubrac cattle, a robust and hardy race, are retained. The calves are sold for veal, at from 3*d.* to 3½*d.* per lb., live-weight, or from 3*l.* to 4*l.* per calf.

Several attempts to improve the flock by new blood have failed, because *purchasers could not see the change in the right light*. The woods have received attention, and the chestnut-trees have been restricted to the mountain sides, a reaction against certain ancient edicts which give exemptions and privileges to fields, if planted in chestnut!

If we leave out of account 30 hectares lately reclaimed, the standard of high farming, a head of large stock to 2½ acres (a hectare), has here been reached.

As to profits, former reporters of authority have stated, first, in 1842, that these lands have been tripled in value; and secondly, that fields bought for 3*l.* are worth 19*l.* per acre; still, since M. de Monseignat has undoubted wealth, an impression exists in the neighbourhood that all these changes have been wrought by a large expenditure. Regrets have therefore been expressed that the jury did not fortify their award by a financial statement.

It is said that "without making an *exposé* of a man's private fortune, which the public neither desires, nor indeed implicitly trusts, a jury is always bound to obtain, and may easily furnish, sufficient data, authentic and precise, to guard them against such flat rejoinders as have greeted this adjudication."

So much for the record of this contest, which exhibits quiet but rapid progress in a secluded quarter, and likewise brings out the difficulties attendant on the award of a prize like that of the Prime d'Honneur,—difficulties of sufficient magnitude to suggest mature deliberation in framing the rules, but not the abandonment of the Prize system. The influence of such prizes can hardly be disputed when, from the simple operation of a *local* prize, not only was this secluded district found pre-eminently well prepared for the larger Imperial contest, but the whole Department is described as "on the full march, under its recognised leaders, to agricultural wealth; so much so, that, with other rural prejudices, it has thrown aside the fear of open markets and open competition."

If we attempted to prolong our survey to the bleak slopes of the Alps or Pyrenees, or the sunny plains below, where the olive, vine, citron, orange, and fig-tree strive for the possession of the soil with corn and maize, garance, and other industrial crops, besides violets and other flowers, cultivated on a large scale for perfumes, we should find amidst much general supineness some candidates who richly deserve the crown. Or, again, the sandy

deserts of the south-east would afford us ample proof of modern skill and energy.

But it is not desirable further to extend this paper. Enough has been written to throw some light on the present state of French agriculture, the prospects of which are rather to be measured by its rate of progress, than by its actual average attainments. In estimating those prospects we must pay due regard to the force of good example emanating from numerous centres. The pebble stirring the lake's surface is hardly a more fit emblem of the gradual expansion of intelligent self-love into universal philanthropy, than of the growth and spread from fence to fence of the influence of sound agriculture. In this point of view these splendid prizes may be doing more effectual work than even their authors can recognise. Their operation must be in itself an object of interest to us, who, out of our private purses, expend so large a sum annually on premiums, every one of which has its weak side.

When we are comparing French agriculture with our own, we may naturally be anxious to inquire whether the fiscal burdens imposed upon it are equal to ours; and it may be interesting to know how they are levied and assessed in a country where the vigilance of a central power does much to remove local inequalities.

As competitors in the same markets, we may, perhaps, regard our neighbours' progress with some anxiety, even if it be found that they have no advantage over us in respect of taxation; but, in another larger point of view, we cannot but hail it with unmixed satisfaction. Agricultural progress is the best guarantee for peace; the home farm and its interests are the best antidote to the thirst for glory; and if this was true when farming plodded on in one monotonous round, how much stronger must be its attraction when modern science and enterprise have given a new zest to every season and every operation! To strike for the hearth and the altar, no arm is so strong and resolute as that of the small landholder; no man will so sadly obey the call to foreign service, made by an imaginary dictate of honour. It is to be regretted that among ourselves those classes which once held their land on the *condition* of doing suit and service to their lord or their king, now form so small a portion of the Infantry which bears the motto of "Defence, not Defiance."

If a more complete survey of the most important farms in France could be given, it would be a valuable handbook to the agricultural tourist. In these days all classes find leisure to take a short trip abroad, and a poor, listless sight-seeing recreation it is to the majority. But if the idea of a traveller be ever restored to what it was when the much-enduring Greek Prince *knew the*

mind as well as saw the towns of men, and thereby became one of the most ready-witted of mankind, the farmer, amongst others, will visit foreign countries *with an object*, and he will reap both pleasure and profit from so doing. He will then have a cordial welcome from French agriculturists; because, to quote the language of the leading French agricultural journal,* when recording the death of our late eminent breeder, Mr. Jonas Webb, "in the ranks of those who labour for the advancement of agriculture, the divisions and jealousies which part nation from nation and race from race are unknown." Topics of common interest will abound; some deference, some precedence, even, will be allowed to the English cultivator. He will have but one regret, viz., that he cannot express himself with ease and fluency, on technical points at least, in the French language. If he would remove this disability from himself or his sons, he cannot do better than become a subscriber to the '*Journal d'Agriculture Pratique*,' a number of which journal will be delivered to him by post every fortnight, as easily and regularly as an English newspaper. He will find it, on the whole, the most readable of all modern publications which combine agricultural intelligence with scientific research. To its pages the writer of this paper is indebted for his materials.

III.—On the Absorption of Soluble Phosphate of Lime by different Soils of known composition; and Remarks on the Application of Superphosphate and other Phosphatic Manures to Root-crops. By Dr. AUGUSTUS VOELCKER.

Of all artificial manures none is more largely employed in agriculture than superphosphate of lime, which probably constitutes fully three-quarters of all our chemically-prepared fertilizers. Its manufacture, commenced and at present carried on in England on a gigantic scale, is now rapidly extending on the Continent. At first, bone-dust was the only phosphatic raw material which, by means of sulphuric acid, was converted into superphosphate; but the insufficiency of the supply of bone-dust soon compelled the manufacturer to resort to such other materials as animal charcoal, South American bone-ash, coprolites, apatite, Sombbrero phosphate, Kooria Moorina guano, and various other semi-fossilized phosphatic guanos, until, as a rule, bone-dust is either altogether excluded or but sparingly employed in the manufacture of superphosphate.

* *Journal d'Agriculture Pratique*, Dec. 5, 1862.

As long as bones only were treated with sulphuric acid, a large proportion of the insoluble phosphate of lime—the chief constituent of the incombustible part of bones—was left unchanged in its chemical composition. Such partially dissolved bones, containing seldom more than 8 or 10 per cent. of soluble phosphate of lime, nevertheless produced a more beneficial and rapid effect upon the crops than is explicable by the action of soluble phosphate alone, so that the results obtained must be in part attributed to the bone-dust having become softened by this treatment, and hereby rendered more available for the use of plants.

Satisfied with these results, agriculturists were content to purchase bone-superphosphate, which contained, comparatively speaking, little soluble, and much insoluble, phosphate. But when necessity compelled the manufacturer to substitute mineral phosphates for bone-dust, complaints of a deterioration in the quality of manure were heard on all sides. In many instances these complaints were not without foundation; for in reality superphosphate lost much in value when bone-dust was first replaced by insoluble mineral phosphates. The remedy for this evil, however, was soon found to consist in rendering the mineral phosphate as completely soluble as possible. By the use of a large proportion of acid, our best makers at present convert nearly the whole of the insoluble phosphates in coprolites, apatite, &c., into bi- (or soluble) phosphate of lime; for experience has taught them that mineral phosphates unaltered in chemical composition, are of little more practical value to root-crops than sand; and that, therefore, it is a waste of material to leave mineral phosphates in a turnip-manure, in an insoluble condition.

Such samples appear to produce, though not on all soils, as good a crop of roots as can be desired; nor have we any reason to doubt their efficacy on account of their origin. Since soluble phosphate is a definite chemical compound of one equivalent of lime and one equivalent of phosphoric acid, it would be rather strange if this were not so. As in the case of pure sulphate of ammonia it matters not whether it be prepared from bones or from gas-water, why, in like manner, may not a biphosphate of lime, of the same composition and properties, be obtained indifferently either from bones or from mineral phosphates?

Soluble phosphate unquestionably is the most valuable constituent of commercial superphosphates; for experience has shown that with its percentage, the efficacy of this class of manure generally rises or falls; and though, on light land the use of other fertilizers is desirable for the turnip-crop, still in many cases nothing more or less is required than a fair proportion of soluble phosphate of lime.

In England the application of purely phosphatic manures is confined almost exclusively to root-crops. It may not be amiss, therefore, to inquire why it is that these manures, as a rule, benefit root-crops more than cereals and other crops? The idea naturally suggests itself that turnips or swedes require more phosphoric acid to bring them to perfection than wheat, barley, or oats; and an examination of the ashes of these several crops confirms this impression. A given quantity of ash of turnips, it is true, contains less phosphoric acid than the same quantity of wheat-ash; but since the total amount of mineral matters or ash in a crop of turnips is very much larger than that in a crop of wheat, the amount of phosphoric acid which is removed from the soil by the one is very much more considerable than that taken up by the other.

Taking the average composition of the ash of turnips, bulbs and tops, deduced from the recorded results of numerous experimenters, we have in 100 parts—

	Bulbs.	Tops.
Potash	42.0	20.0
Soda	2.0	3.0
Magnesia	2.0	1.0
Lime	11.5	30.0
Phosphoric acid	9.0	5.0
Sulphuric acid	11.5	11.0
Silica	1.0	1.0
Chloride of sodium	6.0	8.0
Chloride of potassium .. .. .	..	5.0
Carbonic acid	15.0	16.0
	<hr/> 100.0	<hr/> 100.0

The average composition of the ash of the grain and straw of wheat is as follows:—

	Wheat.	Straw.
Phosphoric acid	50.0	5.0
Sulphuric acid .. .. .	.5	2.7
Silica	2.5	67.0
Lime	3.5	5.5
Magnesia	11.5	2.0
Potash	30.0	13.0
Soda	2.0	4.8
Chlorides of potassium and sodium .. .. .	..	..
	<hr/> 100.0	<hr/> 100.0

If we suppose the crop of bulbs of the turnips to weigh 20 tons per acre and the tops 6 tons, and take the average percentage of ash in the bulbs at .70 and that in the tops at 1.7, we remove from each acre, in round numbers—

	lbs.
In the bulbs	314 mineral matter.
In the tops	223 ..
	<hr/> 542

The 314 lbs. of mineral matter in the bulbs, and 228 lbs. in the tops, consist of—

	Bulbs.	Tops.
	lbs.	lbs.
Potash	132	45½
Soda	6½	7
Magnesia	6½	2½
Lime	36	68½
Phosphoric acid	28½	11½
Sulphuric acid	36	25
Silica	3	2½
Chloride of sodium	19	18½
Chloride of potassium .. .. .	..	11½
Carbonic acid	47½	36½
	<hr/> 314	<hr/> 228

An average crop of turnips thus removes from the soil 28½ lbs. of phosphoric acid in the bulbs and 11½ lbs. in the tops,—39½ lbs., or, in round numbers, 40 lbs. in all.

The grain of wheat, on an average, contains 1·7 per cent. of ash, and wheat-straw 5 per cent.

The mean produce of wheat per acre, taken at 4 quarters,—32 bushels at 60 lbs. the bushel, is 1920 lbs. of wheat; and as straw, being generally twice the weight of the grain, would weigh 3840 lbs.—

.. In 1920 lbs. of wheat there are	32½	lbs. of mineral matter.
In 3840 lbs. of straw there are	192	..

Total mineral matter per acre 224½

According to the preceding analytical results, the mineral matters in the grain and straw of wheat per acre consist of—

	Wheat.	Straw.
	lbs.	lbs.
Phosphoric acid	16½	9½
Sulphuric acid	½	5½
Silica	1	128½
Lime	1	10½
Magnesia	3½	3½
Potash	9½	25
Soda .. .. .	..	..
Chlorides of potassium and sodium .. }	½	9½
	<hr/> 32½	<hr/> 192

A fair average crop of wheat thus removes from the soil 16½ lbs. of phosphoric acid in the grain, and 9½ lbs. in the straw—together 25½ lbs., or in round numbers, 26 lbs. Therefore a turnip-crop weighing 20 tons per acre takes 14 lbs. more phosphoric acid out of the soil than 32 bushels of wheat and the straw belonging to it.

If we suppose the turnips to have been grown with 3 cwts. of superphosphate, containing 20 per cent. of soluble and an inappreciable amount of available insoluble phosphate, the manure will supply 31 lbs. of phosphoric acid, and the remaining 9 lbs. must be derived from the soil. Yet although the larger amount of phosphoric acid contained in a crop of turnips accounts to some extent for this crop being more benefited by phosphatic manures than wheat, I believe the principal cause of the more energetic and striking effect which such manures produce on root-crops than on cereals, more especially wheat, will be found in the different mode in which green and white crops take up food from the soil, and the different duration of their period of growth. The roots of wheat, as is well known, penetrate the soil to a much greater depth than the more delicate feeding-fibres of the roots of a turnip. Wheat, remaining on the ground two to three months longer than turnips, can avail itself for a longer period of the resources of the soil; therefore in most cases the phosphoric acid disseminated through the soil is amply sufficient to meet the requirements of the wheat-crop; whilst turnips, depending on a thinner depth of soil during their shorter period of growth, cannot assimilate sufficient phosphoric acid to come to perfection. This is, I believe, the main reason why the direct supply of readily-available phosphates is so beneficial to root-crops and not to wheat.

This view of the matter, if I am not mistaken, gains strength by the fact that barley, a crop which in many parts of England is often sown late in the season, and generally later than any other white crop, is much more improved by superphosphate of lime than oats or wheat. On late sown barley this fertilizer has a strikingly beneficial effect. When the land has not been well done before, or is naturally poor, and the barley backward, a top-dressing of 3 cwts. of superphosphate will be found most useful. In that case a still better manure will be a mixture of superphosphate and guano in equal proportion, applied at the rate of 3 to 4 cwts. as a top-dressing. A crop of barley does not contain more phosphoric acid than a wheat-crop, and yet I have repeatedly noticed the effects produced on it by the application to the preceding crop of 3 to 4 cwts. of superphosphate made entirely from mineral phosphates, and containing no ammonia whatever. Although the superphosphate was applied to the preceding root-crop, and no other manure with it, and the turnips were carried off the land, it nevertheless produced on the succeeding barley an effect as plainly visible as is the case when barley is top-dressed with nitrate of soda or sulphate of ammonia.

Ammoniacal manures or nitrate of soda, I may state in passing, have never given a satisfactory economical result in my

barley experiments. It thus appears that phosphatic manures produce a more beneficial effect on barley than upon wheat, and ammoniacal manures a more striking effect upon the latter than upon the former. As both barley and wheat belong to the same natural family of plants, and barley does not contain more phosphoric acid than wheat, it may be safely inferred from this fact, that the cause of the greater efficacy of phosphates for barley is intimately connected with the shorter period during which barley remains on the ground, in an actively-growing state.

The later the barley-crop is put into the soil the more beneficial an application of superphosphate will be found. Such a dressing moreover has the additional advantage of encouraging early maturity, and producing a finer sample of grain; whilst ammoniacal manures, on the contrary, retard the ripening of the crop.

In a warm climate or a good season, ammoniacal salts may be used with much greater propriety and more largely, other circumstances being equal, than in a colder country or in an ungenial season. For a similar reason, it is more dangerous to sow barley very late on soils highly manured with nitrogenised animal fertilisers, than on poor land. In the former case the barley often does not get sufficiently ripe to be of any use for malting; whilst in the latter, very fair malting-barley is often obtained, contrary to all expectation. It thus appears that the ash analyses of our cultivated crops, do not by themselves afford a sufficiently trustworthy guide to the practical farmer in selecting that kind of manure which is best applied to each crop.

I should much regret to appear to undervalue the merits of those chemists whose labours have made us acquainted with the composition of the ashes of plants. The recognition of the fact that the mineral matters composing the plant-ashes are not accidental but essential constituents, without which no plant can grow and come to perfection, has indisputably had a powerful influence on modern agriculture. The ash-analyses of plants unquestionably are useful in many respects, although they have not realised the hopes which many persons entertained at one time. The composition of the ashes of a plant certainly does not in itself afford sufficient data to determine with anything like certainty, or even probability, which fertilising constituents or manuring mixtures should be applied to the various crops usually cultivated in this country, in order to produce satisfactory results. Still a knowledge of the composition of the ashes of plants gives us a salutary warning that our crops will remain but scanty, or become unhealthy, if the soil on which they are grown is

either wanting altogether or contains an insufficient supply of one or more of these essential ash-constituents.

Thus we may learn from the composition of the ash of turnips, and the amount of mineral matters in an average crop, that at the very least 177½ lbs. of potash, 104½ lbs. of lime, and 40 lbs. of phosphoric acid must be present in an available condition in the soil or the manure, or both together, if we wish to grow 20 tons of bulbs and 6 tons of tops. If, for instance, the soil be deficient in either lime or potash, and none is applied, the turnips are likely to become diseased, or the crop deficient in quantity, though the other mineral and organic substances useful to turnips are present in abundance.

It has indeed been observed that the exclusive use of superphosphate, however beneficial it may be in the majority of instances, has in some soils led to a complete or partial failure, or the presence of disease in the turnip-crop. Again, instances are on record in which neither superphosphate nor bone-dust have had any effect on turnips; and good root-crops have been obtained without any phosphatic manures.

It thus appears that the effects of superphosphate of lime upon the turnip-crop vary according to the soil it is grown upon; and it is a subject of considerable practical importance to investigate the reasons of these variations, and to point out under what circumstances phosphatic manures may be advantageously applied, either alone or in conjunction with farmyard-manure, guano, or other more complex fertilizers.

1. Superphosphate, it appears to me, is efficacious in many instances as a manure for root-crops, because soils in general seldom contain more than one to two tenths of a per cent. of phosphoric acid, which acid is required in a considerable quantity by turnips, and because the short period of active growth of the crop necessitates a far more abundant supply of phosphoric acid than is contained in the portion of the soil reached by the fibres of the turnip. The direct and exclusive supply of phosphoric acid, however, is attended with beneficial results only when the soil, in addition to a fair amount of organic matter, contains an abundance of available potash, lime, and the other mineral matters entering into the composition of the ash of turnips. In that case the only deficiency in the soil is available phosphoric acid; and the want is best supplied by soluble phosphate.

2. Soluble phosphate of lime, the most active constituent of commercial superphosphate, made entirely from mineral phosphates, may either be washed out by heavy or long-continued rains, or undergo changes in some soils which render it ineffective.

3. The soil may contain already an abundance of phosphates in a sufficiently available condition to meet the requirements of the turnip-crop. In that case it is plain a mineral superphosphate cannot produce any effect.

4. Though highly desirable for the growth of turnips, mineral superphosphate of lime does not provide organic matter, nor potash or carbonate of lime. Some soils, especially sandy soils, are greatly deficient in all these elements of fertility; and as superphosphate, unlike farmyard-manure, does not supply them all, the turnip-crop, not finding the proper description of food in the soil which it requires, becomes diseased or fails altogether, though superphosphate may have been used in large doses.

There are thus at least four essentially different conditions to which root-crops may be exposed with respect to soil and purely phosphatic manure.

The first being the most frequent, perhaps, may be called the normal condition in which we find turnips. On many farms, where a rational system of rotation is pursued, and no sign of disease in the root-crops has ever been noticed, superphosphate is the only manure which is directly applied to swedes or turnips. Notwithstanding the absence of organic matter and ammoniacal salts in the phosphatic manure, good root-crops are generally obtained when the land, more or less stiff in character, has been well cultivated in autumn and during the early part of spring, and a finely-pulverised surface-soil been obtained by these means. Such land contains an amount of clay which in most cases provides root-crops with an abundance of all the necessary soil-constituents. But nevertheless an economical supply of superphosphate at the first period of growth seems to be most beneficial.

The acknowledged power which purely phosphatic manures possess of pushing on the young turnip-plant appears to indicate that but very few soils contain an amount of phosphoric acid which renders the direct application of superphosphate altogether superfluous. A great number of soil analyses made by many chemists of note have indeed proved this to be a fact.

It is worth our while to notice also the care which is taken by Nature to provide plants at their earliest periods of existence with a constituent which possesses so remarkable an effect in pushing on the young plant, but is seldom present in soils in larger proportions than a mere fraction of a per cent. On examining the ashes of the seeds of all plants, it will be found that all contain much phosphoric acid, either in combination with alkalis, or with lime or magnesia. During the germination of the seeds the phosphates contained in them appear to be rendered soluble. The most important mineral

food-constituent is thus provided by the seed itself, and placed within easy reach of the infant plant just at a time when the amount of phosphoric acid in almost all soils would be inadequate to induce a vigorous development of the whole vegetable organism.

Direct experiments, extending over a period of five years, have shown me that on the moderately tenacious calcareous clay soils on our farm, as large an increase in the produce of swedish-turnips may be obtained with bone-ash treated with sulphuric acid, as by any other of the numerous fertilising mixtures which I have employed in field-trials. My own experience receives a confirmation in the practice of many farmers who grow good root-crops on soils similar in composition to ours, with nothing else but 3 or 4 cwts. of superphosphate, the composition of which exhibits neither organic matter nor salts of ammonia.

The soils on our farm, on which such a dressing was applied with most signal success, resembled much in composition and general character, the field selected for experimental trials in 1860. The soil in this field contains hardly any sand that can be separated by the mechanical processes of washing and decantation, and consists of a mechanical mixture of clay, calcareous gravel, and organic remains. An analysis of it furnished the following results:—

Moisture (when analysed)	3·960
Organic matter and water of combination	9·616
Oxide of iron and alumina	19·660
Carbonate of lime	3·805
Sulphate of lime	·345
Phosphoric acid	·075
Magnesia	·783
Potash	1·239
Soda	·090
Insoluble siliceous matter (chiefly clay)	60·525

100·098

It will be seen that this soil contains a notable quantity of available potash as well as lime and organic remains, and, like most others, contains but little phosphoric acid.

On clay soils of a similar chemical constitution, I believe the application of a sufficient quantity of soluble phosphate will be found to render the direct supply of other fertilising matters superfluous in growing turnips. At all events the result of numerous experiments has shown me that on such soils nitrogenised matters do not increase the efficacy of soluble phosphates in a turnip-manure.

It has been stated, in the second place, that the exclusive employment of mineral superphosphates for root-crops is pro-

ductive of harm, or at the best does no good, in perhaps not a few instances; and this may be due to the porosity and light character of some soils, in consequence of which the soluble phosphates are washed away by heavy rains, or suffer changes which render them ineffective.

With a view of ascertaining whether this supposition is likely to be correct, I have carefully studied the changes which soluble phosphate undergoes, when brought into contact with various kinds of soils of known composition.

The soils used in the following experiments were—

- A. A red loamy soil.
- B. A calcareous soil.
- C. A stiff clay subsoil.
- D. A stiff clay surface-soil.
- E. A light sandy soil.
- F. A clay-marl.

In the case of the first five soils a superphosphate was employed, containing 37·20 per cent. of bone-earth rendered soluble by acid; in the sixth experiment the superphosphate used contained 23·84 per cent. of soluble phosphate. The superphosphate was free from organic matter and salts of ammonia.

Absorption of Soluble Phosphate by a Red Loamy Soil.

EXPERIMENT A.—In the first set of experiments a deep, red loamy soil, well suited to turnips, was employed. This soil was found on analysis to contain in 100 parts:—

Moisture	2·95
Organic matter and water of combination	6·75
Oxides of iron and alumina	6·10
Carbonate of lime	1·22
Alkalies and magnesia	1·20
Insoluble siliceous matter (clay and sand)	82·22

100·44

5250 grains, or 12 oz. of this soil, were mixed with 109·34 grains of superphosphate, containing 37·20 per cent., or 40·67 grains, of bone-earth rendered soluble by acid, and the whole repeatedly shaken up in a Winchester stoppered bottle with $1\frac{1}{2}$ pint, or 13125 grains, of distilled water. After a lapse of twenty-four hours 3500 grains of the supernatant liquid were drawn off. The amount of bone-earth in this perfectly clear solution was next determined, and found to weigh 4·37 grains.

The total amount of liquid (13,125 grains) consequently contained 16·38 grains of bone-earth; and, deducting these 16·38 grains from 40·67—the amount of soluble bone-earth originally

used—we find that 24·29 grains, or rather less than two-thirds of the total amount of soluble phosphate were absorbed by 12 oz. of this red loamy soil after a lapse of twenty-four hours. The remaining liquid was then left in contact with the same soil for eight days, and the bottle containing the solution and soil shaken up at intervals. At the commencement of this second experiment the bottle contained besides the soil 9625 grains of water and 36·30 grains of soluble phosphate after the removal of 4·37 grains in 3500 grains of water. After eight days 3500 grains of the remaining solution were again drawn off. The proportion of bone-earth in this quantity of liquid was now found to weigh only 2·45, or at the rate of 6·73 grains for the 9625 grains of water:—

Amount of bone-earth in bottle after 24 hours ..	26.80
" 9625 grains of solution in the bottle	6.73
Total amount of bone-earth absorbed by 12 oza. of soil after 8 days	29.57

The remaining 6125 grains of the liquid in the bottle were finally left in contact with the same soil for twenty-six days, when 3500 grains of liquid were again drawn off, and they were found by accurate determination to contain only .65 grains of bone-earth, an amount equivalent to 1.13 grains in the 6125 grains of water.

In the second experiment 2.45 grains of soluble phosphate had again been removed in 3500 grains of water; so that only 33.85 grains remained, of which 32.72 grains had been absorbed in twenty-six days by the soil, only 1.13 grains being then left in solution.

Supposing the whole of the solution had been drawn off in each of these three successive Experiments, it would have contained—

					Grains.	
After 24 hours	..	..	..	..	16.38	of soluble bone-earth.
" 8 days	..	..	..	..	9.18	"
" 26 days	..	..	..	..	2.44	"

And the 12 ounces of Soil would have removed from the 40·67 grains of soluble Bone-earth which were originally used—

								Grains.
After 24 hours	--	--	--	--	--	--	--	24.29
" 8 days	--	--	--	--	--	--	--	31.49
" 26 days	--	--	--	--	--	--	--	38.23

We thus see that in this case the absorption of soluble phosphates was not complete even after twenty-six days; and that a heavy shower of rain falling within twenty-four hours of the application of superphosphates rich in soluble phosphates, would

wash a good deal of this valuable fertilising substance into the subsoil, and render it unavailable to the young turnip-plant, if the amount of soluble phosphate which is usually added to the soil were as large as in my experiments.

But practically our dressings of superphosphate are applied in very different proportions. Supposing a heavy dose of 6 or 8 cwts. of a concentrated superphosphate to have been added to only 2 or 3 inches of surface soil, we shall find on calculation that the proportion which the earth in the field bears to such dressings is many hundred times greater than that which the 12 oz. of soil used in my experiments bears to the soluble phosphate then supplied; whilst in relation to 3 or 4 inches of surface soil, the quantity of soluble phosphate contained in 6 or 8 cwts. of a rich superphosphate is so small that we cannot detect by analysis any difference in the amount of phosphoric acid present in the soil before and after it has received such a dressing of superphosphate. Although, therefore, a limited quantity of this loamy soil left a considerable proportion of valuable phosphate in solution, I think we may rest assured that even in the most unfavourable circumstances the complete absorption of this valuable fertilising constituent is secured in practice by the large amount of soil through which its solution has to pass.

Absorption of Soluble Phosphate by Calcareous Soil.

EXPERIMENT B.—I next selected for experiment a calcareous soil, which contained in 100 parts—

Moisture	3.62
Organic matters	4.23
Carbonate of lime	67.50
Oxides of iron and alumina	7.54
Magnesia	4.4
Potash and soda	7.9
Insoluble siliceous matter (fine clay)	15.88
	<hr/>
	100.00

The preponderating constituent, the carbonate of lime, was here found in a finely divided state, as is frequently the case in chalky soils.

1½ lb. (or 10,500 grains of this *Calcareous Soil*, 218.22 grains of *Superphosphate* (containing 81.17 grains of *Soluble Phosphate*), and 3 pints (or 26,250 grains) of *Distilled Water* were mixed, as in *Experiment A*.

After 24 hours, 7000 grains of the liquid being drawn off, were found to contain 2.23 grains of bone-earth; so that the whole 3 pints held in solution 8.36 grains of bone-earth. Hence, since the whole amount of bone-earth in the mixture was 81.17 grains, the 1½ lb. of soil had absorbed 72.81 grains in 24 hours. (The

bone-earth is here absorbed in a much larger ratio than by the red loam.)

After 8 days (the bottle now containing 19,250 grains of water), 7000 grains of the liquid being filtered off, were found to contain only .23 grains of bone phosphate. Hence the 19,250 grains of water held in solution only .63 grains. Therefore, after 8 days, the soil had altogether absorbed 78.31 grains of bone phosphate.

After 26 days the liquid was found to contain no appreciable amount of bone-earth.

Supposing the whole Solution to have been drawn off in each stage of the Experiment, it would have contained—

	Grains.
After 24 hours	8.36 of soluble phosphate.
„ 8 days .. ..	.86 „
„ 26 days	none.

And the soil would have absorbed—

	Grains.
After 24 hours	72.81
„ 8 days	80.31
„ 26 days	81.17 or the whole amount of soluble phosphate.

Thus the chalky soil absorbed the soluble phosphate much more rapidly and perfectly than the loam, which contained but little lime. Yet even in the presence of a great excess of finely-divided carbonate of lime the absorption of the soluble phosphate is not instantaneous, nor is it completed in twenty-four hours. In both sets of experiments the same relative proportions of soil, water, and soluble phosphate were employed; the results are therefore strictly comparable.

Absorption of Soluble Phosphate by a stiff Clay Subsoil.

EXPERIMENT C.—I next selected some very stiff Essex clay, sent to me some time ago for examination by Mr. Mechi, of Tiptree Hall, considering that such a choice would afford a useful contrast and standard of comparison with the preceding experiments.

100 parts of this subsoil in an air-dry condition contained:—

Moisture	9.46
Water of combination and a little organic matter ..	4.87
Oxides of iron and alumina	17.38
Phosphoric acid .. ..	.06
Carbonate of lime	1.02
Sulphate of lime .. ..	.13
Magnesia .. ..	.92
Alkalies and leys .. ..	.45
Insoluble siliceous matters (clay)	65.71

100.00

E

This soil, it will be noticed, contains but little carbonate of lime, and much oxide of iron and of alumina in a hydrated condition. In this state both these oxides unite readily with phosphoric acid to form combinations insoluble in water. When the acid biphosphate of lime is brought into contact with alumina or oxide of iron, it loses part of its acid, which combines with these oxides, and becomes converted into basic or insoluble phosphate of lime.

Clay soils invariably contain some, and in many instances a good deal of these oxides. Theoretically they may therefore be regarded as good absorbers of soluble phosphate, even if they do not contain any carbonate of lime; and the following experiments confirm this expectation.

12 oz., or 5250 grains of this Subsoil, 109·33 grains of Superphosphate (containing 40·67 grains of Soluble Phosphate), and $1\frac{1}{2}$ pint, or 13,125 grains of Distilled Water, were mixed, as in Experiments A and B.

After 24 hours, 3500 grains of the liquid being drawn off were found to contain 5·70 grains of soluble phosphate, so that the whole $1\frac{1}{2}$ pint of liquid held in solution 21·37 grains of bone-earth. Hence, since the whole amount of bone-earth in the mixture was 40·67 grains, the 12 oz. of soil had absorbed 19·36 grains of bone-earth in 24 hours.

Again, after 8 days (the bottle now containing 9625 grains of water), 2400 grains of the liquid being filtered off perfectly clear, were found to contain 2·38 grains of bone-earth. Hence the 9625 grains of water held in solution 9·54 grains of bone-earth instead of 15·68, as after 24 hours' contact with the soil. Therefore, after 8 days, the soil had altogether absorbed 25·43 grains of bone-earth.

After 26 days (the bottle now containing 7225 grains of water), 2100 grains of clear liquid being drawn off, were found to contain 1·74 grains of bone-earth. Hence the 7225 grains of water held in solution 5·94 grains of bone-earth. Therefore, after 26 days, the soil had altogether absorbed 26·65 grains of bone-phosphate.

It may be noticed that, after 24 hours, actually more soluble phosphate was contained in the liquid than passed into the soil. During the third stage of the experiment only 1·25 grains of bone-earth were added to the soil.

The results are subjoined in a tabulated form.

Supposing the whole solution to have been drawn off in each stage of the Experiment, it would have contained—

				Grains.
After 24 hours	..	..	..	21·37 of soluble phosphate.
„ 8 days	..	..	..	13·01 „
„ 26 days	..	..	..	10·87 „

And in that case 12 oz. of this soil would have absorbed—

After 24 hours	..	..	..	19·30	„
„ 8 days	..	..	..	27·66	„
„ 26 days	..	..	..	29·80	„

Absorption of Soluble Phosphate by a stiff Clay Surface Soil.

EXPERIMENT D.—The surface soil resting on the preceding clay subsoil, on analysis, was found to consist in 100 parts of—

Water	3.91
Organic matter and water of combination	4.80
Oxides of iron and alumina	7.85
Phosphoric acid .. .. .	.04
Carbonate of lime	2.08
Sulphate of lime .. .. .	.15
Magnesia and alkalis .. .. .	.32
Insoluble siliceous matter (clay)	80.85
	<hr/>
	100.00

5000 grains of this Soil, 110.64 grains of Superphosphate (containing 41.15 grains of Soluble Phosphate), and 21,000 grains of Distilled Water, were mixed as in the previous Experiments.

After 24 hours, 7000 grains of liquid being drawn off, were found to contain 6.9 grains of phosphate, so that the whole 21,000 grains held in solution 20.70 grains. Hence the soil had absorbed 20.45 grains or very nearly half the soluble phosphate.

After 8 days (there being now 14,000 grains in the bottle) 7000 grains were drawn off, and found to contain 5.40 grains, so that the 14,000 grains held in solution 10.80. Hence the soil had now absorbed 28.45 grains.

After 17 days, it was found that the 7000 grains of water now left in the bottle contained 2.14 grains of phosphate, so that the soil had absorbed in all 26.71 grains.

Had the whole solution been drawn off in each of these three successive Experiments, it would have contained—

	Grains.
After 24 hours	20.70 of bone-earth.
„ 8 days	16.20 „
„ 17 days	6.42 „

And 12 oz. of soil would have absorbed—

After 24 hours	26.45 „
„ 8 days	24.95 „
„ 17 days	34.73 „

It thus appears that the absorption of soluble phosphate took place very imperfectly after eight days, and that after seventeen days an appreciable quantity of soluble phosphate was still left in the liquid.

Both the surface and clay subsoil, in the proportions in which they were used, possessed the power of rendering soluble phosphates insoluble in a far less degree than the chalky soil.

Absorption of Soluble Phosphate by a light Sandy Soil.

EXPERIMENT E.—The next three experiments will show whether the prevailing impression is correct, that on light sandy soils a

superphosphate soon loses its efficacy; inasmuch as its valuable constituent, the soluble phosphate, is readily washed away by the rainfall. The soil now used was taken from an extremely sandy field, which apparently contained but little clay and organic matter, and no limestone gravel whatever. The red colour of this soil indicated the presence of much oxide of iron, and its light porous character proved it to be a ferruginous sand. On analysis it yielded the following results:—

Water	.. .. .	1.43
Organic matter	.. .. .	3.39
Oxides of iron and alumina	.. .. .	12.16
Carbonate of lime	.. .. .	.15
Alkalies and magnesia	.. .. .	.46
Phosphoric acid	.. .. .	traces
Insoluble siliceous matter (sand)	.. .. .	82.41
		<hr/>
		100.00

The amount of lime in this soil, it will be seen, is very trifling; but there is present a good deal of hydrated oxide of iron and some alumina, which was determined together with the oxide of iron.

5000 grains of this Soil, 110.40 grains of Superphosphate (containing 40.93 grains of soluble Bone-Earth), and 21,000 grains of Distilled Water, were mixed as in the previous Experiments.

After 24 hours, 7000 grains of the liquid being drawn off, were found to contain 6.49 grains of phosphate, so that the whole 21,000 grains held in solution 19.47 grains. Hence the soil had absorbed 21.46 grains of the bone-earth.

After 8 days (there being now 14,000 grains of water in the bottle), 7000 grains were drawn off, and found to contain 5.67 grains of bone-earth, so that the 14,000 grains held in solution 11.34 grains. Hence the soil had absorbed 23.10 grains of the bone-earth.

After 17 days, it was found that the 7000 grains of water now left in the bottle contained 3.90 grains of bone-earth, so that the soil had absorbed 24.87 grains of bone-earth.

Had the whole Liquid been drawn off in each case, we would have found in the Solution containing 40.93 of soluble Phosphates—

	Grains.
After 24 hours	19.47 of bone-earth.
„ 8 days	17.01 „
„ 17 days	11.70 „

and in 5000 grains of soil,

	Grains.
After 24 hours	21.46 of insoluble phosphate of lime.
„ 8 days	23.92 „
„ 17 days	29.23 „

It appears, then, that such soils, when left in contact with

solutions holding soluble phosphates, do not, after twenty-four hours, absorb that substance as freely as the soils previously operated upon.

Absorption of Soluble Phosphate by a Marly Soil.

EXPERIMENT F.—The soil employed in the following experiment, on analysis, was found to consist, in 100 parts, of—

Moisture	4.72
Organic matter and water of combination	11.03
Oxides of iron	9.98
Alumina	6.06
Carbonate of lime	12.10
Sulphate of lime .. .. .	.75
Magnesia and alkalis	1.43
Soluble silica (soluble in caustic potash)	17.93
Insoluble siliceous matter (chiefly clay)	36.00
	<hr/>
	100.00

16,000 grains of this soil were mixed with 213.59 grains of superphosphate and placed in a bottle, and with 20,000 grains of distilled water. During the first three days the bottle-contents were frequently agitated; 8000 grains more of distilled water were then added, and thereby the solution made up to 4 decigallons. The liquid was next allowed to stand at rest, and, after seven days from the commencement of the experiment, 5000 grains of the solution were drawn off, and the perfectly clear solution evaporated to a small bulk. In the concentrated liquid the soluble phosphate was determined in the usual way, and found to amount to .38 grains:—

	Grains.
The amount of soluble bone-earth in 4 decigallons of solution, before contact with soil, was	79.43
In 7 days, there remained in the solution	2.13
	<hr/>
Bone-earth absorbed by the soil	77.30

Thus nearly the whole amount of soluble phosphate became insoluble on remaining in contact with this soil for seven days. The same experiment was repeated in precisely the same manner, and the solution left in contact with the soil for fourteen days; at the end of which time it contained only 1.06 grains, the soil having absorbed 78.37 grains.

Marly, like chalky soils, it appears from my experiments, have a much greater power than others of absorbing soluble phosphate—in other words, of rendering soluble phosphate insoluble. The lime in soils of that description is unquestionably the sole

agent which produces this change. The reconversion of soluble into insoluble phosphate perhaps may appear undesirable, but in reality it is not only beneficial but absolutely necessary to the healthy and luxuriant development both of turnips and of all other crops to which superphosphate is applied. No acid combination, as such, can enter into plants without doing them serious damage; even free vegetable acids, such as humic and ulmic acids, are injurious to all crops cultivated for food for the use of man or beast; and unless these acids, which are always present in what practical men call sour humus, are neutralized by lime, or marl, or earth, none but the roughest and most innutritious herbage can be grown. Earth of almost any description is a universal neutralizer of acids; and for this reason any kind of earth may be used with more or less advantage for improving peaty land. If the earth or soil is rich in lime, or contains an appreciable quantity of it, so much the better; but even should it be destitute of lime, or nearly so, still any earth, except a pure white sand, will be of considerable use in improving peat-land of any description by neutralizing injurious acids, apart from its mechanical tendency to consolidate loose or spongy soil.

Free mineral acids are, I believe, still more injurious to all farm-crops, and perhaps to all plants, than the free organic acids which are frequently found in humus. A very dilute solution of sulphuric acid—say 1 part in 1000 of water—may be used with advantage for killing grass in gravel-walks made with flint or quartzose sand; after one or two applications, the weeds will be destroyed, and will not reappear for a long time. But if the walks are made with limestone gravel, the application of a much stronger acid has little or no effect on the grass or weeds; after some time the latter indeed seem to grow all the better for having had a taste of dilute sulphuric acid. In reality, however, no acid enters the plant, but on coming in contact with the limestone gravel unites with the lime to form that useful fertiliser sulphate of lime or gypsum. Flints and pure quartz-sand, on the other hand, contain hardly anything else but silica, which, in a chemical point of view, is an acid, and therefore cannot neutralise another acid. Dilute sulphuric acid, therefore, remains in a free state in the flint or quartz-gravel; and in the measure in which it is absorbed by the roots of the grass or other weeds destroys their vitality. These examples thus prove unmistakably that a soil which contains free acids in ever so small a quantity is unfit to maintain a healthy growth. We have, therefore, strong presumptive evidence that soluble phosphate, a combination which has a strongly acid character, does not, as such, enter the roots of plants, for we know that its application

to the land is invariably beneficial and never hurtful. The preceding experiments place this beyond doubt; for they prove that soils of most varied characters—clay or sand, chalk or loam—render soluble phosphate insoluble. Although some soils possess this power in a higher degree, and some effect this change more rapidly than others, it may be safely asserted that there is no arable soil which does not possess it to a considerable extent. If there were any such soil, the application to it of acid soluble phosphate would, we may rest assured, do harm to the crop; for in water containing ever so little free acid no plant can exist in a healthy condition for any length of time.

The proportion of soluble phosphate to that of the soil in my experiments was taken purposely very much larger than it ever will be found in practice; and as in every instance quite a limited quantity of soil rendered a large proportion of the soluble phosphate insoluble, it cannot be doubted that the whole amount of soluble phosphate in 4 or 6 cwt. of concentrated superphosphate will be retained in a neutral and insoluble condition in the large bulk of soil to which it is applied. The assumption that this fertiliser does not sustain the after-growth of turnips, because the soluble phosphate which it contains is less readily washed into the subsoil, is thus founded in error. Equally fallacious is the dictum of some agricultural chemists who maintain that a good turnip-manure should contain one-half of its phosphates in a soluble, and the other half in an insoluble condition, in order that the soluble phosphates may push on the young plant, and the insoluble phosphates vigorously maintain its after-growth. In reality soluble phosphate, soon after its application, is converted in the large mass of soil into insoluble phosphate; and the first as well as the sustained invigorated growth of our root-crops is alike promoted by insoluble phosphatic combinations. If, therefore, it is at all desirable to submit phosphatic materials to the action of sulphuric acid, which renders the phosphates soluble, we should aim at perfection, and not be led astray by fallacious speculations and perform this work by halves. Practical proofs are not wanting which clearly demonstrate the efficiency of superphosphate, containing, practically speaking, no insoluble phosphate of lime. It will suffice to mention only one that will be found in my Paper on Experiments upon Swedes, in vol. xxii. part 1, of this Journal.

One of the experimental turnip-plots was manured with 3 cwt. of dissolved bone-ash, prepared by treating 100 lbs. of good commercial bone-ash with 70 pints of brown sulphuric acid, and drying up this mixture with 50 lbs. of gypsum. In this way an excellent superphosphate was obtained, which on analysis furnished the following results:—

Moisture	5.65
Organic matter	3.51
Bi-phosphate of lime	19.64
Equal to bone-earth rendered soluble	(30.65)
Insoluble phosphate of lime .. .. .	.86
Hydrated sulphate of lime (gypsum)	64.96
Alkaline salts	1.83
Sand	3.55
	<hr/>
	100.00

Practically speaking, the manure contained no insoluble phosphates, and was free from ammoniacal salts and nitrogenised organic matter:—

	tons.	cwts.	qrs.	lbs.	
The unmanured plot produced, per acre }	14	14	1	4	of Swedish turnips.
The manured plot produced, per acre }	20	15	2	24	„
Thus yielding an increase of, per acre }	6	1	1	20	„

Scarcely any of the twenty experimental plots, in which all kinds of fertilising mixtures were tried, yielded so large an increase as this plot, manured, it will be seen, with a superphosphate in which all the phosphates were rendered soluble, and which contained no ammonia or nitrogenised organic matter.

Again, it may be asked, How is it that the effects of soluble phosphate are frequently observed, not only in the turnip-crop, but in the succeeding barley? If soluble phosphate were as easily washed out of the soil as is supposed by some, it surely could not exert any influence on the barley-crop.

In the opinion of many farmers superphosphate only benefits the crop to which it is applied, whilst bone-dust maintains the fertility of the land for several years. This no doubt is quite correct if a large dose of half-inch bones is applied to the land on the one hand, and a scanty dressing of superphosphate on the other. But if the quantities of phosphate of lime put on in the one shape and in the other be equal, I have no hesitation in saying that the effects of the latter will be greater, and the practical result will be a larger produce. If this produce be removed from the land, the phosphate contained in it, as a matter of course, will likewise be removed from the soil. On the other hand, the application of the less efficacious insoluble phosphates in bone-dust generally produces a smaller crop; and if this is also removed from the land, less phosphates are removed in it than in the former instance. A larger amount of phosphate of lime consequently will be left in the soil; and thus bone-dust, as far as its phosphates are concerned, appears to be more permanent in its effects than superphosphate. This greater per-

manency, however, is no recommendation whatever; for the primary use of all manures is to enable us to grow, not scanty, but heavy crops—not to deposit on the land fertilisers which may last for three or four years, but by prompt, efficacious action to render a quickly remunerative return from a moderate outlay.

The advantage of bone-dust over superphosphate, as far as the phosphates in both are concerned, is only apparent, not real; for the soluble phosphates in the latter, as has been shown, are retained in the soil in an insoluble condition, in which they cannot be washed out so readily as is commonly believed.

The question may be asked: If soluble phosphate is rendered insoluble in coming into contact with the soil, which is really the case, why incur all the expense and trouble of treating bone-dust and similar phosphatic materials with oil of vitriol? In answering this question, the following explanation may be given. The treatment of bone-dust, bone-ash, and other phosphatic materials with oil of vitriol results, in the first place, in the more or less complete disintegration of their structure, and in the next, in the production of soluble or acid phosphate, which, when neutralised, as we have seen, by contact either with lime or with oxides of iron or alumina in the soil, in either case is reconverted into an insoluble phosphate in a highly divided condition; and as this change takes place in the soil itself, a most intimate and uniform incorporation of the phosphates with the soil is effected. However finely ground bone-dust may be, the division, being effected by purely mechanical means, necessarily must leave the phosphates in a state which may be called extremely coarse in comparison with that resulting from their solution in acid.

Precipitated phosphates not only are greatly more bulky than the finest powder obtained by mechanical means, but are also more soluble in water than merely powdered phosphate of lime. Though identical in composition, the fine state of subdivision of the particles which constitute precipitated phosphate of lime imbues the latter with properties that do not belong to bone-powder. Thus, for instance, weak vinegar readily redissolves precipitated bone-phosphates, but has hardly any effect upon even fine bone-dust.

The whole secret of the energetic action of superphosphate thus depends upon the production of most minutely subdivided or precipitated insoluble phosphates within the soil itself, not, as is erroneously supposed, on the direct absorption of soluble phosphates by plants; and it is not desirable to effect the precipitation before the manure is put on the land, for by so doing

we should lose all the advantages resulting from equal distribution of the phosphates and their incorporation with the soil.

The more rapidly the soluble phosphates in superphosphate are precipitated or rendered insoluble in the soil, and the more uniformly these highly-divided insoluble phosphates are distributed in that portion of the surface-soil which is just under the young turnip-plant, the more energetic their effects. Superphosphate acts a great deal more energetically when applied with the liquid than with the dry drill; according to practical men, 2 cwts. of superphosphate applied with water frequently produce as good an effect as 3 or 4 cwts. in a dry state.

A little consideration will explain this difference. In the first place, superphosphate, in the shape of a powder, cannot be so uniformly distributed on the land as it is in a liquid condition. In the next place, the acid or soluble phosphate may, and often does, remain unchanged in the soil for a long time when superphosphate is applied in a dry state, and no rain falls for some time, or the manure is badly prepared. In dry weather the soluble phosphate remains as such where it has been deposited; when rain falls, as is frequently the case, in insufficient quantity to dissolve the soluble phosphate and to produce at once a dilute solution, a proper distribution in the soil is not effected. In other words, there will be too much phosphate in one place and none in another. And, besides this, more or less acid phosphate will be left that cannot exert any beneficial effect on the young turnips. I have frequently picked up on fields bits of superphosphate a month or six weeks after its application, and found in them still a considerable proportion of acid or soluble phosphate of lime, notwithstanding that some rain had fallen during that time. There cannot, therefore, be much doubt that in superphosphate applied in a dry state frequently a large proportion of the phosphates remains inactive in the soil just at the period when phosphates are most needed by the young plants.

On the other hand, if superphosphate mixed with a sufficient quantity of water is put on the land with the liquid-drill, the whole amount of the acid or soluble phosphate in the manure is at once brought into contact with a portion of the surface-soil, and by it rapidly precipitated and changed into insoluble phosphate. Applied with water, the manure thus is not only uniformly distributed on the land, but its most valuable constituent is rapidly changed by the soil into the most active condition in which it can be presented to the young turnip-plants.

We can thus readily explain the fact that in many instances 2 cwts. of superphosphate produce as good a crop of swedes when

applied with the liquid-drill as 4 cwts. or more of the same manure applied dry.

The application of superphosphate by the liquid manure drill certainly must be regarded as practically the most economical, and philosophically as the most rational, mode of incorporating this turnip-manure with the land.

In the beginning of this paper I expressed the opinion that superphosphate may occasionally be ineffective as a turnip-manure, because the soils to which it is applied may contain a sufficient proportion of phosphates to meet all the requirements of the turnip-crop.

Several striking instances which have been brought under my notice have shown me that this is indeed the case. In the neighbourhood of Swindon, I am informed by Mr. Stratton that neither superphosphate nor bone-dust has much, if any, effect on the crops to which it is applied.

Again, in the neighbourhood of Ilchester, I met with an unquestionable instance of a soil on which superphosphate, as well as other purely phosphatic manures, had no effect whatever on roots.

I have heard of many other such localities, and have no doubt that there are soils in other counties besides Wilts and Somersetshire on which this class of fertilizers has no effect on root-crops nor on pasture land.

I have examined the soil from the neighbourhood of Ilchester. It is a soil resting on the lower chalk, or rather the junction of the lower chalk and greensand formation, and contains a great deal more phosphoric acid than is usually found in most fertile soils.

It is likewise an interesting fact that in the neighbourhood of Swindon, where I am informed phosphatic manures are of no use, coprolitic nodules have been found. I have in my possession specimens of phosphatic nodules from the neighbourhood of Swindon, and highly phosphatic marls from other parts of Wiltshire. If in other localities phosphatic manures are unavailing, the intelligent observation of this apparently anomalous fact may there also lead to the discovery of valuable deposits of mineral phosphates.

In the fourth place, it has been stated in the beginning of this paper, that a purely mineral superphosphate may fail to produce good turnips, because in addition to the phosphoric acid it does not provide the crop with the requisite amount of potash, lime, and organic food, which it finds in land of a better description.

This part of our subject deserves a careful examination, inasmuch as it has been stated that the exclusive use of mineral

superphosphate is the cause of the diseases to which roots of late years have become more exposed than formerly.

Whether turnips and swedes are really now more liable than formerly to contract disease it is not for me to decide ; probably the more extended growth of green crops has something to do with this generally received opinion. But there can be but little doubt that roots are often grown on some soils naturally most unsuited to green crops, and that on others farmers often put too much reliance on the use of superphosphate.

Noticing only the final failure in the crop, and not the first effect which superphosphate did produce, practical men are apt to ascribe the failure to the superphosphate, and not to the great poverty of the soil in other mineral and organic constituents not supplied by superphosphate. This, like other special manures, should only be used exclusively in special cases, and not on land in which a general deficiency suggests at once the simultaneous application of another more complex and general manure like farmyard-manure. There are many sandy soils on which roots cannot be grown with superphosphate alone, for the simple reason that these soils do not contain the proper amount of potash and lime or organic matters which is needed by the turnip-crop.

In a former contribution to this Journal I mentioned an instance of failure from the use of superphosphate, which is so much to the point that I may be allowed to refer to it again.

It occurred on a farm at Ashton Keynes, a village about six miles from Cirencester. On visiting this farm, Mr. Plumbe, the occupier, directed my attention to a field of considerable extent on the slope of a hill. Surrounded by a tract of country visibly abounding in limestone-gravel, the field on the slope and top of the hill presented a striking contrast, even to a superficial observer, with the fields at the base of the hill. These were moderately stiff, full of limestone-gravel, and the root-crops on them looked healthy, promising a fair average yield. The elevated field in question, on the contrary, was sandy in the extreme, apparently contained but little clay, no limestone-gravel whatever, and the turnips on it were affected by anbury to such an extent as I never witnessed before.

There was hardly a sound turnip to be seen, except on two isolated spots. With this exception, the whole of the roots were so much injured by the disease that it was not considered worth while to send sheep over the field. I was informed that, after the turnip-seed was drilled in with superphosphate, the young plants came up well, looked remarkably strong and healthy up to the time of singling, and promised to be a very fine crop.

However, soon after, their growth was checked, and the roots, on inspection, were found to be all more or less attacked. They presented a most extraordinary appearance, being forked and twisted into the most fantastical forms and covered with wart-like excrescences, exhibiting thus the character of anbury in its most malignant form. Part of the field was covered with a brownish-coloured sandy soil, part with a red-coloured ferruginous soil. Both these soils, and the subsoil on which the red-coloured soil rested, were analyzed, and furnished the following general results :—

	No. 1.	No. 2.	No. 3.
Organic matter and water of combination	5·36	4·82	7·64
Oxides of iron and alumina	5·78	12·16	22·77
Carbonate of lime	·25	·15	·44
Alkaline salts and magnesia	·41	·46	·69
Phosphoric acid	traces	traces	traces
Sulphuric acid	·08	not determined	
Insoluble siliceous matter (chiefly sand)	88·12	82·41	68·46
	100·00	100·00	100·00

No. 1 was taken from the top of the hill, where the turnips were most affected by anbury.

No. 2 was a red-coloured soil from the slope of the hill, where the turnips were likewise much diseased.

No. 3 was a deep-red-coloured ferruginous subsoil, on which No. 2 rested. In this case, the manure evidently carried on the plant up to a certain point, and then failed to bring the crop to maturity. Now, if we look at the composition of these sandy soils, we cannot feel surprised that on such land superphosphate alone did not produce sound roots.

In the first place, the proportion of lime, especially in the surface-soils, is totally inadequate to meet the wants of the crop of turnips. We cannot doubt, therefore, that this deficiency was one, if not the principal, cause of failure.

In the next place, the amount of available alkalis is very small, as it often is on sandy soils, and there was an insufficient amount of organic matter, which appears to be highly beneficial in such soils to root-crops, and neither of these two deficiencies did the superphosphate in any way correct. But even here the superphosphate did not fail to manifest its usual invigorating effect upon the young plant, showing plainly that it did answer the purpose for which it is so justly renowned. If through its instrumentality alone sound roots were not matured, we must not lay the blame to its charge, but rather blame ourselves for not also providing with the phosphates the requisite amount of organic matters, lime, and potash, to the absence of which the

unhealthy growth and presence of disease at a later stage are attributable.

The additional potash which is indispensable for roots grown on sandy soils is most economically supplied in good rotten dung or in liquid manure ; but it is also furnished to a considerable extent by Peruvian guano, wood-ashes, and burnt clay. To these resources we must, therefore, look if we wish to avoid the disappointment of losing our root-crops.

When turnips are intended to be grown on light land, we should, in the first place, ascertain if it wants liming or not, and treat it accordingly. In the next place, it should receive a fair dressing of good rotten dung, or, if this cannot be had in sufficient quantity, half a dressing of dung should be given, and afterwards 2 or 3 cwts. of Peruvian and 2 or 3 cwts. of superphosphate should be supplied when the seed is drilled in. Such an *addition* of superphosphate to farmyard manure or guano has a most beneficial effect.

Perhaps the best manure for growing roots on light land is a mixture of bone-dust and rotten dung. On several farms in Norfolk this mixture is used, in preference to all other manures, with most signal benefit.

The best way to make this mixture is to cart into a corner of the field the yard-manure about three months before turnip-sowing begins. At the same time the bone-dust—calculating 6 to 8 bushels per acre—is carted next to the place where the manure is to be put up in a heap. In making the heap, first a thick layer of dung is placed upon the ground ; a thin sprinkling of bone-dust is put upon it, then a layer of dung ; again a sprinkling of bone-dust ; and so on, until all the bone-dust and dung are placed in alternate layers in a heap. About a month before sowing the turnips the heap should be turned over. Proceeding in this way, we shall find that the fermented dung disintegrates and partially dissolves the bone-dust to such an extent that by the time the manure is ready to be distributed over the turnip-field nearly the whole of the bone-dust will have become decomposed and uniformly amalgamated with the dung. This excellent plan appears to me by far the most economical mode of dissolving and applying bone-dust on light land, which, as has been stated, should, if possible, be manured with at least half a dressing of ordinary yard-manure, in order that the deficiency of potash and organic matter in the soil may be supplied.

In conclusion, the principal points of interest which have been discussed at some length in the preceding pages may be condensed into the following Summary.

SUMMARY.

1. A crop of turnips, weighing per acre 20 tons of roots and 6 tons of tops, removes from the soil 177½ lbs. of potash, 104½ lbs. of lime, and 40 lbs. of phosphoric acid.

2. Phosphatic manures appear to hasten on early maturity; ammoniacal salts to retard it.

3. Phosphatic manures, especially in cold or wet seasons, produce more nutritious roots than ammoniacal manures, and a finer sample of wheat or barley than the latter.

4. Late-sown barley, or barley grown on land out of condition, is much improved by superphosphate, or, better still, by a mixture of equal parts of superphosphate and guano, applied at the rate of 3 to 4 cwts. per acre.

5. In a warm climate or a good season, ammoniacal salts may be used with greater advantage than in a colder country or in an ungenial season.

6. The ash-analyses of plants do not afford a sufficiently trustworthy guide to the practical farmer in selecting the kind of manure which is best applied to each crop.

7. The ash-analyses of plants, however, teach the important practical lesson that certain mineral matters in certain proportions are essential to the luxuriant growth of all cultivated plants; and that our crops must remain scanty or become diseased if the soil on which they are grown is deficient in one or more of the essential ash-constituents of plants.

8. Superphosphate of lime, applied to root-crops, has a different practical effect on different soils.

9. Few soils contain an amount of phosphoric acid which renders the direct application of phosphatic manures superfluous.

10. On good calcareous clay soils and land that is moderately stiff and in good heart, heavy crops of swedes and turnips may be grown with no other manure than superphosphate rich in soluble phosphate.

11. 3 to 4 cwts. of mineral superphosphate is a sufficient dressing per acre on such land.

12. The addition of ammoniacal salts to phosphates in many instances produces no beneficial effect on turnips grown on calcareous clay soils.

13. Phosphatic manures are inefficacious on some soils which, like those in the greensand formation, contain a much larger proportion of phosphoric acid than is common.

14. Soluble phosphate of lime is the most valuable constituent of commercial superphosphates.

15. All arable soils have the power of absorbing or rendering soluble phosphate insoluble.

16. Chalky and marly soils possess this property in a higher degree than clay or sandy soils.

17. The absorption of soluble phosphate by soils is never instantaneous, but requires some time.

18. In practice the large extent of absorbing surface and heavy weight of the soil through which a solution of soluble phosphate has to pass before it can escape, secure its perfect absorption.

19. Plants do not take up the acid biphosphate or soluble phosphate as such.

20. Since the soluble phosphate in superphosphate of lime is rendered insoluble in all soils, and the first as well as the after-growth of turnips is alike promoted by insoluble phosphates, it is erroneous to consider that soluble phosphate feeds the turnip-crop in its first stages of existence, and insoluble phosphate sustains its after-growth.

21. The doctrine that, of the phosphates in a turnip-manure one-half should be soluble, and the other insoluble, is based on erroneous speculations.

22. Of two turnip-manures containing an equal amount of phosphates, that which contains the largest amount of soluble phosphate is more valuable than the other containing the largest amount of insoluble phosphates, both manures being alike in other respects.

23. In preparing superphosphate from mineral phosphates, the latter should be rendered soluble as completely as possible.

24. Superphosphate is not deteriorated by keeping for any length of time.

25. When incorporated with the soil the fertilising properties of superphosphate are retained for any reasonable length of time, and its effects frequently seen in the barley-crop on land on which turnips were grown in the preceding year with superphosphate.

26. The secret of the energetic action of superphosphate depends on the production of most minutely subdivided or precipitated insoluble phosphates within the soil itself, and not on the supposed, but erroneous, direct assimilation of soluble phosphate by plants.

27. Precipitated insoluble phosphate of lime is vastly more bulky and more soluble in pure water than the finest powder obtained by mechanical means.

28. The more rapidly and completely the soluble phosphate in commercial superphosphates and turnip-manures is precipitated and rendered insoluble in the soil, the more energetic will be its effect upon the turnip-crop. This advantage is best secured by applying the manure with the liquid-drill.

29. The application of superphosphate by the liquid manure

drill is the most economical, efficient, and rational mode of incorporating turnip-manure with the land.

30. Purely mineral superphosphates fail to produce good turnip-crops on light sandy soils.

31. Superphosphate cannot be considered as the cause of the diseases to which roots are liable.

32. Roots grown on poor sandy soils exclusively with superphosphate nevertheless are liable to become diseased, or to fail altogether.

33. The deficiency of lime, organic matters, and especially potash in sandy soils, accounts for the difficulty of growing good roots on such land with purely phosphatic manures.

34. On light soils turnips should always be grown with, at least, some farmyard manure.

35. Bone-dust, partially dissolved by acid, is a better manure for turnips on light land than a purely mineral superphosphate.

36. On light land a mixture of equal parts of guano and superphosphate is better turnip-manure than either manure applied alone.

37. Liquid manure is very beneficially applied to root-crops on light land.

38. An excellent plan of applying bone-dust to the turnip-crop on light land is to ferment it with dung.

39. This is best done by putting alternate layers of dung and bone-dust in a heap three or four months before turnip-sowing begins, and to turn the heap about a month before it is distributed on the field.

Royal Agricultural College, Cirencester, January, 1863.

IV.—*On the Utilisation of Town Sewage.* By J. B. LAWES, F.R.S., F.C.S.

No one can read the evidence given before the Select Committee "On Sewage of Towns," appointed by the House of Commons last Session, without being struck with the great differences of opinion elicited during the examination of the witnesses. Whilst one and all agree that sewage is a most valuable manure, containing every constituent necessary to be applied to the land for our crops, they differ in a remarkable degree both as to the commercial value of a given amount of sewage, and as to the quantity requisite to be applied to a given area of land.

One witness who had been engaged for years in the application of sewage, and whose evidence is said in the "Analysis of Evidence" to be "entitled to great weight," gave it as his

opinion that 300 tons of sewage per acre would accomplish the same results as the 10,000 tons which he had in point of fact applied! Another witness, just returned from a visit of inspection of the sewage meadows at Edinburgh and Rugby, considered the inferiority of the produce at Rugby to be due to the much smaller quantity of sewage there applied, the amount ranging from 3000 to 9000 tons per acre; whilst, in the case of the Edinburgh meadows to which he referred, it was estimated by the same witness at 10,000 to 12,000 tons per acre, and to be as high as 30,000 to 40,000 tons on some of the meadows in that locality.

As to the money value of the excrementitious matters of each person contributing to sewage, it was assumed that the results recorded by one witness showed it to be about 20s., and those of another about 1s. 9d. per head per annum. Again, estimates of the value of a ton of sewage varied from about a halfpenny to about 9d. And, finally, the evidence showed that in some cases the sewage of only about two persons, and in others that of 300 or more, had been applied to an acre of land.

The Royal Sewage Commission, appointed some years ago "to inquire into the best mode of distributing the sewage of towns, and applying it to beneficial and profitable uses," in the prosecution of their inquiry, visited almost every locality where town sewage was applied in any way to the purposes of agriculture, and the evidence they collected was almost as conflicting as that published by the Committee of the House of Commons above referred to. Feeling how important it was that the public should be put in possession of more exact and reliable data on a subject involving such vast sanitary and economical interests, the Commission, of which I am a member, decided upon instituting some careful experiments on the agricultural application of sewage. The experiments were made at Rugby, upon grass-land, on which, as above alluded to, the sewage was applied at the rate of from 3000 to 9000 tons per acre per annum, and the Report, giving the results obtained in the first season (1861), has already been presented to both Houses of Parliament.*

It is proposed to lay before the readers of the 'Journal of the Royal Agricultural Society' such portions of this report as bear more directly upon the interests of agriculture.

As, however, the Committee of the House of Commons, in their "Analysis of Evidence" above referred to, give it as their opinion "that sewage is applicable to all crops, and that if commercial results are sought for, it should be applied in small

* "Second Report of the Commission appointed to inquire into the best mode of distributing the Sewage of Towns, and applying it to beneficial and profitable uses." (1862.)

dressings," it may appear to some that it would have been well had the Commission experimented upon corn and other crops as well as grass, and applied the sewage in smaller quantities per acre. It may be advisable, therefore, to mention some of the circumstances which influenced the Commission in limiting their experiments in the first instance to grass alone, and in deciding upon the quantities of sewage to be applied. It will be sufficient to cite the previous experience obtained at Watford, Rugby, and Edinburgh on these points.

The chairman of the Commission, the Earl of Essex, who rents the sewage of the town of Watford, had laid down pipes for its application over 210 acres of mixed arable and grass-land; but had been led by experience to limit the application to but a small proportion of that area, and almost exclusively to either permanent meadow, or Italian rye-grass. Indeed, in his evidence before the Committee of the House of Commons last year, his Lordship stated that practically he limited the application to about 10 acres of Italian rye-grass, and 35 acres of meadow-land; for the former of which he required about 5000 tons per acre per annum; and that for the latter the amount remaining at his disposal was inadequate.

At Rugby about 6700 of the population contribute to the sewage, and pipes were laid down for its application to about 470 acres of mixed arable and grass-land. The quantity of sewage pumped daily (which is by no means the total yield of the town) averages about 750 tons, and, reckoning 300 working days, this gives a supply of 225,000 tons per annum. If this amount were equally distributed over the 470 acres piped for its application, the supply would be something less than 500 tons sewage per acre per annum. But when the Commission first visited Rugby, in order to arrange with Mr. Walker, the proprietor of the land and of the sewage works, and with Mr. Campbell, the tenant of about 190 acres, for the use of a few acres of the land, and a supply of sewage, they found that the practical experience of some years had led to the limitation of the application almost exclusively to grass, and also, in a great measure, to the abandonment of the use of the hose and jet, and the substitution of open runs. The sewage, instead of being applied to 470 acres of mixed arable and grass land, was limited to but a fraction of that area; and Mr. Campbell, who had pipes laid down for about 190 acres, and was paying rent accordingly, had abandoned the use on all but about a dozen acres of permanent meadow or Italian rye-grass.

Neither Mr. Campbell, nor the present or previous tenant of the other portion of the land laid out for sewage irrigation at Rugby, was examined before the Committee of the House of

Commons last year; but in a pamphlet since published by the former gentleman, giving the results of his experience for eight years as a sewage farmer, he states "that he should expect a better paying return from 50 acres with 4500 tons per acre per annum, than from 100 acres with 2250 tons per acre."

It seemed impossible to account for the abandonment, at Watford and at Rugby, of the use of sewage to crops generally, and in comparatively small amounts per acre, after so large an outlay had been incurred, entirely with a view to its application in these very ways, excepting on the supposition that the practice was not found to be profitable; and, to say nothing of evidence derived from other sources leading in the same direction in regard to the points in question, the Commission would hardly have been deemed justified in instituting experiments at Rugby in accordance with the plans originally adopted there on a more extensive scale than anywhere else, and abandoned, as unprofitable, after the experience of some years. It was, therefore, decided to confine the experiments, at any rate in the first instance, to grass land; to apply as a minimum as small a quantity of sewage as, having regard to the evidence at command, appeared likely to be effective; and, to apply as a maximum an amount below the quantities known to be employed at Edinburgh with so much success.

Extracts from the Report of the Royal Sewage Commission.

"At Rugby the whole of the available sewage of the town is rented by G. H. Walker, Esq.; and, after being collected in a large tank erected for the purpose, it is distributed, by means of a steam-engine, through iron pipes laid down for the supply to about 470 acres of mixed arable and grass land; hydrants being fixed at intervals along the lines for surface distribution, either by hose or open runs. These arrangements were obviously well adapted for the purposes of the inquiry the Commission had in view. Experience, at Rugby as well as elsewhere, seemed clearly to indicate that, to obtain the largest amount and value of produce at the least proportionate cost for distribution, dilute liquid sewage should be applied to the growth of succulent crops; and that it is best adapted for grass. It was decided, therefore, to confine the experiments, at any rate at present, to grass land. Accordingly, the Commission availed themselves of the kindness of G. H. Walker and J. A. Campbell, Esqs., to operate upon about 15 acres of grass land in the neighbourhood of Rugby supplied with sewage as above described.

"It also appears that produce of the kind in question is better adapted for the feeding of cows for the production of milk than

for any other purpose. It was decided, therefore, to devote the produce of one portion of the sewage-irrigated grass land to be cut green and given to milking cows. It, nevertheless, seemed desirable to test the fattening qualities of such produce, when cut green, and given to stock in the fresh state; and also to determine how far it is adapted for making into hay. Accordingly, it was proposed that the produce of a second portion of the experimental land should be given in the green state, to fattening oxen; and that that of a third should be made into hay, provided that the season and other circumstances would allow of it.

"Assuming that the ultimate object of the experiments is to provide such information as may be taken as the basis of arrangements for the application of the sewage of towns in the manner the most advantageous both to urban and rural interests, it is sought to determine, as far as possible:—

"1. The amount and composition of the produce, in relation to the volume of water supplied to the land by irrigation, to the amount of manurial constituents so applied, and to the population contributing the manurial constituents to the water.

"2. The most profitable method of applying the produce; that is whether it should be used in the green state or as hay; whether for the production of milk or of meat; and whether it should be consumed alone, or in conjunction with other food.

"The 15 acres of grass land consisted of two fields, the one of five, and the other of ten acres. For the purpose of the experiments they were laid out, by Mr. Bickford, in small surface drains, or 'runs,' according to the plan described in Vol. XIII. of the 'Journal of the Royal Agricultural Society of England;' and, at the upper end of each a tank holding $3\frac{1}{2}$ tons has been fixed, by means of which the amount of sewage applied to any given portion of land is accurately gauged. From these tanks, too, when full, samples of the sewage-water are taken, at stated intervals, for the determination of its chemical composition. The field of 10 acres has been divided, by an iron bullock-fence, into two equal parts. There were thus at command three portions of land of five acres each; these were respectively set out into four plots to be treated as follows:—

"Plot 1. To be unsewaged.

"Plot 2. To be irrigated with sewage at the rate of 3000 tons per acre per annum.

"Plot 3. To be sewaged at the rate of 6000 tons per acre per annum.

"Plot 4. To be sewaged at the rate of 9000 tons per acre per annum.

"The produce of one set of experiments has been given, in the green state, to fattening oxen; that of the second set (in the same condition) to milking cows; and that of the third (though, as afterwards explained, very little sewage was applied to it) has been made into hay.

"The results obtained in the first year's experiments, conducted as above described, are briefly summarised, under separate heads, in the present short Report. . . . It will be obvious, however, that the results of a first season only must be taken as little more than initiative on many points; and that their numerical indications cannot be taken as the basis of safe deduction in regard to the economical questions at issue without much caution and reservation.

"I. Quantities of Sewage applied, and of Green Produce obtained."

"TABLE I.—Showing the number of Tons of Sewage-water applied on each Plot, up to the end of October, in each of the two Fields.

FIRST SEASON, 1861.

	SEWAGE-WATER PER ACRE.					
	Five-acre Field.			Ten-acre Field (half).		
	Plot 2.	Plot 3.	Plot 4.	Plot 2.	Plot 3.	Plot 4.
	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
March	632·05	1045·12	1444·16	..	..	..
April	279·85	666·40	1176·98	563·04	1145·91	1376·91
May	75·82	96·49	97·66	18·32	64·14	118·82
June	78·78	223·32	577·23	..	..	392·26
July	531·67	430·18	654·05	512·01	392·18	905·73
August	130·60	580·17	787·28	225·90	316·30	595·11
September ..	143·14	703·32	614·72	33·98	517·72	381·81
October	201·69	678·23	800·66	33·98	367·68	455·84
Total	2078·60	4423·23	6152·74	1387·23	2803·93	4226·48
Rate per annum	3110·40	6634·84	9229·11	2378·11	4806·74	7245·39

"In the five-acre field, the produce of which was devoted to the feeding of oxen, the application of sewage did not commence until March 6, 1861, none having been applied in 1860. But the quantities applied on the respective plots up to the end of October were, upon the whole, pretty nearly at the rates intended; namely those of 3000, 6000, and 9000 tons per acre per annum.

"The ten-acre field had been dressed with undetermined amounts of sewage in 1860, and during February of the year of the

“TABLE II.—Showing the Amounts of Green Grass obtained during each separate Month, and in each successive Crop, in the two Fields.
FIRST SEASON, 1861.

GREEN GRASS OBTAINED PER ACRE.											
FIVE-ACRE FIELD.						TWO-ACRE FIELD (half).					
Without Sewage.			With Sewage.			Without Sewage.			With Sewage.		
PLOT 1.	PLOT 2.	PLOT 3.	PLOT 4.	PLOT 1.	PLOT 2.	PLOT 1.	PLOT 2.	PLOT 3.	PLOT 4.	PLOT 1.	PLOT 2.
During each separate Month.											
tons cwts. qrs. lbs.	tons cwts. qrs. lbs.	tons cwts. qrs. lbs.	tons cwts. qrs. lbs.	tons cwts. qrs. lbs.	tons cwts. qrs. lbs.	tons cwts. qrs. lbs.	tons cwts. qrs. lbs.	tons cwts. qrs. lbs.	tons cwts. qrs. lbs.	tons cwts. qrs. lbs.	tons cwts. qrs. lbs.
May... ..	3 2 3 27	..	7 19 1 23	..	4 10 1 1	0 14 0 20	1 4 0 10	2 5 0 0	..	..	..
June	3 1 0 8	2 8 0 15	4 6 0 26	6 14 0 13	0 8 1 18	5 5 1 2	5 4 1 7	8 16 1 4	..	..	..
July .. ..	..	3 16 2 23	4 12 2 8	5 19 2 24	1 6 3 9	0 10 2 26	4 12 1 1	1 16 3 27	..	..	..
August ..	2 2 2 8	1 3 0 12	6 5 1 7	5 0 0 5	2 3 2 7	0 11 0 13	1 15 0 3	4 16 2 2	..	..	..
September	0 19 0 18	2 11 3 0	0 8 0 24	0 16 0 23	0 9 0 8	3 19 1 15	4 0 3 7	3 6 0 0	..	..	..
October ..	..	..	3 9 1 6	4 2 0 5	..	..	..	..	..	..	..
November	..	..	..	..	..	..	..	..	..	..	..
December	..	..	..	..	..	..	..	..	..	..	..
Total ..	9 5 3 5	14 16 3 8	27 1 0 10	32 16 3 8	8 18 0 15	15 16 3 2	22 15 2 12	26 13 3 13	..	..	..
In each successive Crop.											
1st Crop	6 4 0 7	7 5 1 1	10 7 0 24	13 5 1 22	4 18 2 19	9 18 3 12	11 5 3 2	11 1 1 4	..	..	..
2nd Crop	3 1 2 26	4 3 1 25	7 8 1 0	9 15 0 11	3 19 1 24	3 11 0 0	5 18 2 17	7 1 2 6	..	..	..
3rd Crop	..	3 4 0 11	5 16 1 8	5 14 0 26	..	3 2 3 16	5 3 1 0	8 2 2 2	..	..	..
4th Crop	..	0 3 3 27	3 9 1 6	4 2 0 5	..	0 4 0 2	0 7 3 21	0 2 2 0	..	..	..
Total ..	9 5 3 5	14 16 3 8	27 1 0 10	32 16 3 8	8 18 0 15	15 16 3 2	22 15 2 12	26 13 3 13	..	..	..

the experiments (1861), by the previous tenant; it had been fed down very close by sheep and other stock, up to nearly the end of March; and the application of sewage, under the direction of the Commission, did not commence until April 1. Unfortunately the amount of sewage available in this field was very much less than was desired, so much so that the plots on the portion allotted to be cut green for milking cows did not receive the quantities intended, even though, after a few weeks, the application on the portion devoted to hay was entirely abandoned, in the hope of securing enough for the other.

"In both fields, owing to derangement and repair of the works, the supply of sewage was very inadequate during portions of the growing months of May and June.

"The upper portion of the Table (II.) shows the distribution of the produce of the respective plots throughout the season, according to the amounts of sewage applied; and the lower part shows the amounts of produce yielded in each successive crop under the same variation of circumstances. The results, as given in the upper portion, show not only how very much more total produce was obtained by the application of sewage, but also over what a much more extended period of the season an abundance of green food was obtainable when large quantities of sewage were applied; and it should be observed that, in both fields, plots 3 and 4, to which the largest amounts of sewage were applied, might with advantage have been cut earlier, and they would then have yielded much larger crops during May than are recorded for that month. On the other hand, in some cases not inconsiderable amounts of produce were obtained even as late as November. It is, however, probable that, in practice, it will not be advantageous to cut later than October; and it was only done in this case as a means of better estimating the quantity of the produce yielded. The lower portion of the Table shows that there is, in almost every case, an increase of produce at each successive cutting with each increase of sewage applied. It will be seen further on that the produce of the earlier cuttings contained a larger proportion of dry substance than that of the later ones; and also that the sewaged grass differed considerably both in the proportion and composition of its dry substance according to the quantities of sewage applied, and still more from the unsewaged grass.

"The proportion of produce obtained to sewage applied is better seen in Table III., where the amounts of sewage intended, and actually applied up to the end of October, the amounts of total produce, and the amounts of increase of produce for each 1000 tons of sewage applied, are given side by side.

"TABLE III.—Showing the Quantities of Sewage applied up to the end of October, and the total Amounts of Green Grass obtained per Acre, &c.

FIRST SEASON, 1861.

	SEWAGE.			PRODUCE.	
	Quantities required.		Quantities actually applied to end of October.	Total Green Grass per Acre.	Increase of Green Grass for each 1000 tons of Sewage applied to end of October.
	Per Annum.	To end of October.			

Five-acre Field.—Produce given to Oxen.

	tons.	tons.	tons.	tons cwt. qrs. lbs.	tons cwt. qrs. lbs.
Plot 1 (2 cuttings) ..	None.	None.	None.	9 5 3 5	..
Plot 2 (4 cuttings) ..	3000	1981	1872*	14 16 3 8	2 19 1 7
Plot 3 (4 cuttings) ..	6000	3962	4423	27 1 0 10	4 0 1 9
Plot 4 (4 cuttings) ..	9000	5942	6153	32 16 3 8	3 16 2 6

Half of ten-acre Field.—Produce given to Cows.

	tons.	tons.	tons.	tons cwt. qrs. lbs.	tons cwt. qrs. lbs.
Plot 1 (2 cuttings) ..	None.	None.	None.	8 8 0 15	..
Plot 2 (4 cuttings) ..	3000	1769	1387	15 16 3 2	4 19 3 23
Plot 3 (4 cuttings) ..	6000	3538	2804	22 15 2 12	4 18 3 23
Plot 4 (4 cuttings) ..	9000	5308	4226	26 13 3 12	4 4 0 20

"The two fields were nearly a mile apart; the five-acre field was nearly level, and the ten-acre one considerably sloping. When, in addition to these facts, the different previous treatment of the two fields, as already referred to, the different amounts of sewage actually applied up to the dates ending the experimental season, and the fact that the dates of the cuttings on the respective plots differed according to the amounts of sewage, and the consequent progress of the grass, are taken into consideration, it appears probable that the amount of produce would, under equal circumstances, bear a very close relation to the quantity of sewage applied, pretty nearly up to the maximum limit contemplated.

"The produce without sewage was, in each field, equal to more than two and a-half tons of hay per acre. It was rather less in the ten-acre field than in the other; owing, doubtless, to the fact that the grass had there been fed down so close in March, before the commencement of the experiment.

"In the five-acre field the increase of green grass obtained for each 1000 tons of sewage applied, was scarcely 3 tons, where the application was at the rate of about 3000 tons per acre per annum;

* "In this case, the last cutting was on October 9, and the produce is, therefore, calculated against the sewage applied to the end of September only."

fully 4 tons where at the rate of about 6000 tons; and somewhat under 4 tons where at the rate of about 9000 tons. In the ten-acre, and more sloping field, where the sewage was better distributed over the lower and further portions of the plots, and which had been sewaged the year previously, and even early in 1861, before the commencement of the experiments, the increase of green grass for each 1000 tons of sewage experimentally applied was greater, amounting in each case to over 4, and in two out of the three, to nearly 5 tons. As an average of all the results obtained in the two fields, it may be stated, that the amount of increase of green grass yielded for 1000 tons of sewage applied was, in this first year of the experiments, equal to only about three-fourths of a ton of hay.

"II. Results of the Experiments with Oxen.

"Ten Hereford oxen were tied up in a shed; two to be fed on unsewaged grass, and the remaining eight to receive sewaged grass, as it was ready to cut, indiscriminately from the three plots in the five-acre field, to which sewage was to be applied respectively at the rate of 3000, 6000, and 9000 tons per acre per annum. The animals had the grass alone for a period of 16 weeks; namely, from May 27 to September 16. They had then, for a further period of four weeks, in addition to the grass, 4 lbs. of oilcake per head per day.

"The average results over the whole period during which the oxen had grass alone, are given in the following Table (IV.), and to these the few comments that it is necessary to make will be confined. The points shown are, the quantities of sewage designed to be applied, and the quantities actually applied on each plot up to the end of October; the average amounts respectively of unsewaged and of sewaged grass consumed per head daily; the number of weeks the produce of each acre would keep one ox; the pounds of increase in live-weight that the produce of each acre would yield; the value of the increase in live-weight from each acre, at 4*d.* per lb.; and the value of the increase in live-weight obtained from the increase of produce yielded for 1000 tons of sewage applied.

"The oxen weighed more per head than the experimental cows, but their daily consumption per head both of unsewaged and of sewaged grass was considerably less. It is quite obvious from the results given in the Table that grass of the description in question is not adapted for the fattening of oxen without the addition of other food. Indeed, one of the animals on the sewaged grass weighed 52 lbs. less at the conclusion than at the commencement of the experiment; and the maximum increase
of

"TABLE IV,—Showing the Results of the Experiments with Oxen when fed on Green Grass alone.

SEASON, 1861.

	Unsewaged Grass.	Sewaged Grass.			
	Plot 1.	Plot 2.	Plot 3.	Plot 4.	
Tons of sewage to be applied per acre per annum .. .. .	..	3000	6000	9000	
Tons of sewage required to end of October .. .. .	..	1721*	3962	5942	
Tons of sewage actually applied to end of October .. .. .	..	1872*	4423	6153	
Grass consumed per head daily lbs.	89·8	105·2			
Weeks the produce of each acre would keep one ox	33·1	45·1	82·3	99·9	
Increase in live-weight that the pro- duce of each acre would yield lbs.	87·9	134·4	245·0	297·4	
Value of increase in live-weight from each acre at 4d. per lb.	£. s. d. 1 9 4	£. s. d. 2 4 10	£. s. d. 4 1 8	£. s. d. 4 19 2	
Value of increase in live-weight from the increased produce of 1000 tons sewage .. .. .	..	0 8 3	0 11 10	0 11 4	

of any one was 103 lbs. in the 16 weeks, or at the rate of rather less than $6\frac{1}{2}$ lbs. per week. Taking the average of the two and of the eight oxen respectively, those upon unsewaged grass gave scarcely $2\frac{1}{2}$ lbs., and those upon sewaged grass scarcely $2\frac{3}{4}$ lbs., increase per 1000 lbs. live-weight per week; whereas, feeding on good fattening food, such oxen should give 9 to 10 lbs. increase per 1000 lbs. live-weight per week. In fact, these very animals did give increase at this, and even a higher rate, during the subsequent four weeks, when they had, in addition to the grass, 4 lbs. of oilcake per head per day. There can be no doubt, therefore, that with a proper allowance of oilcake, or some such food, a very different result would have been obtained throughout. It was, however, desirable that in the first experiments the grass should be tried alone.

"III. Results of the Experiments with Cows.

"Twelve cows were selected by Mr. Campbell from his large herd, and were placed in a house by themselves. Two of these were to be fed upon unsewaged grass, and the remaining ten upon sewaged grass, mown as it was ready indiscriminately from the three acres receiving respectively different quantities of

* "In this case to the end of September only; see note to Table III."

sewage. Like the oxen, the cows received grass alone for a period of 16 weeks, after which they had a similar addition of oilcake for a period of four weeks.

"Attention will here be confined to the average results over the period of 16 weeks, during which the cows were fed on grass alone. These are given in the following Table (V.), which shows the particulars of the sewage applied to each plot; the average quantity of unsewaged and of sewaged grass consumed by each cow daily; the average yield of milk per head daily; the number of weeks the produce of the respective acres would keep one cow; the number of gallons of milk the produce of each acre would yield; the gross value of the milk from each acre at 8d. per gallon; and the value (at the same rate) of the milk obtained from the increased produce of each 1000 tons of sewage applied.

"TABLE V.—Showing the Results of the Experiments with Cows when fed on Green Grass alone.

SEASON, 1861.

	Unsewaged Grass.	Sewaged Grass.			
	Plot 1.	Plot 2.	Plot 3.	Plot 4.	
Tons of sewage to be applied per acre per annum .. .. .	..	3000	6000	9000	
Tons of sewage required to end of October .. .. .	..	1769	3538	5308	
Tons of sewage actually applied to end of October .. .. .	..	1387	2804	4226	
Grass consumed per head daily lbs.	150·2	124·0			
Average yield of milk per head daily lbs.)	24·89	20·53			
Weeks the produce of each acre would keep one cow	19·0	40·9	58·8	68·9	
Gallons of milk the produce of each acre would yield	321·4	570·7	820·4	961·3	
Value of milk from the produce of each acre at 8d. per gallon	£. s. d. 10 14 3	£. s. d. 19 0 6	£. s. d. 27 6 11	£. s. d. 32 0 10	£. s. d. 32 0 10
Value of milk from the increased produce of 1000 tons sewage	..	5 19 10	5 18 8	5 0 11	

"As already stated, the produce of the three acres of sewaged grass was given to the cows indiscriminately, as it was ready; as, to have done otherwise, on the assumption that the milk-yielding quality of the grass obtained from the land receiving different quantities of sewage was weight for weight different, would greatly have complicated the experiments without the probability that the results could be taken as indicating, with

any certainty, the distinctions supposed. It will be understood, therefore, that the basis of the above estimates as to the amount and value of the milk yielded from each acre is the amount of grass obtained from each acre.

"The results show that the quantity of milk obtainable from the produce of each acre of land depended very much upon the quantity of sewage applied. Deducting the value of the milk produced from the grass of the unsewaged from that from each of the sewaged acres, reckoning it at 8*d.* per gallon, it appears that where about 1400 tons of sewage were applied during the seven months, the produce calculated for each 1000 tons of sewage actually applied gave an increased amount of milk to the value of 5*l.* 19*s.* 10*d.*; where twice that amount of sewage was applied, 5*l.* 18*s.* 8*d.*; and where three times the quantity, 5*l.* 0*s.* 11*d.*

"It will be observed that the cows on unsewaged grass both consumed more and yielded more milk per head per day than those on sewaged grass; but the proportion of milk to a given amount of fresh grass consumed is almost identical in the two cases. As will be seen further on, however, the unsewaged grass contained a considerably higher proportion of dry or solid substance than the sewaged. The question arises whether, or in what degree, the comparatively limited consumption of sewaged grass (with the coincident lower actual yield of milk per head), was due to its very great succulence, the proportion of water to dry substance in the food practically setting the limit to the consumption. However this may be, the result was that a given amount of dry substance of the sewaged grass yielded very much more milk than the same amount of that of the unsewaged.

"IV. *Composition of the Sewage-Water.*

"Samples of the sewage-water, as it was delivered into each field, were taken as follows:—Whilst the sewage was distributing, samples of about a quart were taken at intervals of two or three hours, from the full gauge tank in the field, which held 3½ tons of the fluid. These samples were collected in a carboy for a period of a week, when, after well agitating, a sample of the mixture was sent to Professor Way for analysis. During the first two or three months of the experiments such samples were taken nearly every week, but afterwards only every fourth week. There were thus, for the months of April to October inclusive, 12 samples of sewage-water from each field submitted to analysis."

[The results of the 12 analyses of sewage-water from the five-

acre field are given in Table I., p. 89, and those of the samples from the ten-acre field in Table II., p. 90, in the Appendix.]

"A summary of these, with an additional column, showing the constituents in 1000 tons of sewage, is given in Table VI. below; and the results as there recorded will be sufficient for consideration on the present occasion. There are there given the mean composition per gallon of the 12 samples from the five-acre field, of the 12 from the ten-acre field, and of the 24 samples; also the amount of each of the several constituents in 1000 tons of the sewage-water according to the mean of the 24 analyses.

"TABLE VI.—Showing the mean Composition per gallon, and per 1000 tons, of the Sewage-water.

SEVEN MONTHS—April to October inclusive, 1861.

Constituents.	Mean Grains per Gallon.			Lbs. per 1000 Tons.	
	12 Samples from the 5-acre Field.	12 Samples from the 10-acre Field.	The 24 Samples.		
Organic matter	In solution	10·26	10·30	10·28	329
	In suspension	16·75	11·57	14·16	453
	Total ..	27·01	21·87	24·44	782
Inorganic matter	In solution	36·82	85·85	36·34	1163
	In suspension	16·18	12·55	14·86	459
	Total ..	53·00	48·40	50·70	1622
Total solid matter		80·01	70·27	75·14	2404
Ammonia	In solution	4·99	4·98	4·98	159
	In suspension	1·65	1·16	1·41	45
	Total ..	6·64	6·16	6·39	204
Potass*	1·12	0·95	1·04	33	
Phosphoric acid*	0·87	0·99	0·98	80	

"Reference to the Appendix Tables will show that the composition of the sewage differed very much indeed, and pretty equally so in the two fields, at different periods of the season; depending upon the amount of water reaching the sewers, and the consequent state of dilution of the sewage. The Table given

* "The potass and phosphoric acid were determined in two samples only in each case."

above shows, however, as was to be expected, that the average composition of the sewage collected in the two fields was almost identical. The only difference of any importance is in the amount of suspended matter; there being less organic matter, inorganic matter, and ammonia, in suspension, in the sewage collected in the 10-acre field than in that from the other.

"Without going into any detail on the point on the present occasion, attention may be called to the fact that the column showing the amount of the several constituents in 1000 tons of the sewage, considered in relation to the amounts of increased produce obtained by that quantity of sewage, as shown in Table III., indicates that the constituents of dilute liquid sewage can by no means be valued at the same rates as those in portable, artificial manures, such as guano. In illustration it may be stated that the quantity of ammonia estimated to be contained, on the average, in 1000 tons of the sewage, is equal to the nitrogen of the mixed excrements of about 21 or 22 persons of a mixed population of both sexes and all ages for a year, and to that in about 11 cwts. of Peruvian guano; and the total solid matter in 1000 tons of the sewage is seen to be somewhat more than a ton. The average amount of increase of produce obtained by the application of this large quantity of manurial matter was, however, only equal to about three-fourths of a ton of hay; nevertheless, as has been shown, the increase of grass bore a pretty obvious relation to the amount of sewage employed, until the latter approached (during the actual period of the experiment) the rate of about 9000 tons per acre per annum.

"It is further worthy of remark that the mean composition of the Rugby sewage, as given above, differs comparatively little from that which published analyses indicate for the sewage of London; and the correspondence is the closer when, having regard to the relative amounts of sewage to which the different analyses are applicable, the calculated average instead of the mere arithmetical mean composition of the sewage is taken in the two cases. Thus, the average proportion of total solid matter in the Rugby sewage for seven months, up to the end of October, 1861, was about $77\frac{1}{2}$ grains per gallon, whilst the average amount in London sewage appears to be about 91 grains. The correspondence in the amount of ammonia, which, more than any other constituent, indicates the relation of population to the amount of water, is, however, much more striking. Over the seven months the average amount of ammonia in the Rugby sewage is estimated to be 6.65 grains per gallon; and, founded on the rate of flow of sewage and the analyses given by Dr. Letheby of both the day and night sewage from 10 different sewers, the average amount of ammonia in the sewage of London

is calculated to be 6.66 grains per gallon. Taking 10 lbs. of ammonia to represent the mixed excrements of one individual of a mixed population of both sexes and all ages for a year, 1000 tons of the sewage of either London or Rugby would, according to the above estimates, contain the excrements of about 21 or 22 individuals.

"V. Composition of the Unsewaged and Sewaged Grass.

"It was obviously of great importance to determine the proportion of dry or solid substance contained in the produce cut, weighed, and given to the animals, in a green and very succulent condition; to determine the difference in composition due to the application of sewage; and also that of the successive crops taken at different periods of the season. To this end samples of 2½ lbs. of the unsewaged, or 5 lbs. of the sewaged grass, were taken from every load as soon as it was weighed at the home-stead, the samples from each plot respectively being mixed together day by day as taken, until the cutting of the plot was completed. Each such mixed sample was exposed on sheets of canvas in the open air until sufficiently dry. It was then stored in sacks, and finally cut into coarse chaff, well mixed, weighed, and a weighed portion of the mixture taken for the purposes of analysis."*

* "50 ounces of the coarsely-cut chaff were taken in each case, and each of these samples was carefully divided into 4 equal parts; two of which were fully dried at 212° F. to determine the absolute dry substance, and then burnt to determine the mineral matter, and a third was finely ground, and a portion of it sent to Professor Way for analysis.

"It should here be remarked that there are many practical difficulties in the way of getting accurate results in regard to the amount of dry substance in large bulks of green produce such as those in question. Out in the morning, as the crops always were, the grass generally held a good deal of superficial as well as other moisture, and, with equal conditions of weather, the heavier the crop the greater the amount of water so retained. Again, if the weather were dry and hot, the grass would lose moisture considerably between the time of cutting and that of weighing and sampling at the farm buildings; or, if rainy, the grass would be more or less saturated with water. To add to these difficulties, which are almost inseparable from such an inquiry, the taking of the samples, and their partial drying and preservation, were necessarily left in the hands of those unpractised in such work.

"It will be obvious from the above considerations, that the exact figures given which relate to or involve the question of the proportion of dry substance in the produce must be accepted with some reservation; though it is believed that at any rate the direction and more general indications of the results on the point may fully be relied upon. The results given of the analyses of the dry substance itself will, of course, be much less affected by the irregularities referred to; and the differences in its composition according to the difference in the conditions of growth are points well worthy of a careful consideration in a hitherto untrodden field of inquiry.

"It should be added that, taking advantage of the experience of the past year, all possible precautions are being taken to eliminate avoidable irregularities in the conduct of this part of the work during the present season (1862); and to secure greater uniformity and certainty in the partial drying and preservation of the specimens, a small drying-house, heated by a stove, has been erected."

"TABLE VII.—Showing the Amounts of Dry Substance in the Unsewaged and Sewaged Grass.

FIRST SEASON, 1861.

	Mean per cent. Dry Substance in Fresh Grass.			
	First Crop.	Second Crop.	Third Crop.	Fourth Crop.
Five-acre Field.				
Plot 1 (Unsewaged)	25.1*	27.9	24.4	..
Plot 2 (Sewaged) ..	..	30.5	19.8	18.4
Plot 3 (Sewaged) ..	30.4*	26.9	14.2	13.7
Plot 4 (Sewaged) ..	15.8*	27.7	13.7	12.9
Ten-acre Field.				
Plot 1 (Unsewaged)	22.0	26.9	..	..
Plot 2 (Sewaged) ..	23.3	17.1	12.6	16.9
Plot 3 (Sewaged) ..	21.4	15.1	7.3	15.1
Plot 4 (Sewaged) ..	18.4	16.1	14.4	17.8

"The figures given in the above table show that the proportion of the dry substance in the grass varied very much indeed according to circumstances. The first crop contained generally a higher proportion than the second, particularly in the case of the sewaged grass; and the second, a higher proportion than the third or fourth. It also appears that the unsewaged grass averaged a higher proportion of dry substance than the sewaged. These results are quite in accordance with what would be expected from the known variations in the conditions of growth. The exact proportions of dry substance found, and recorded in the Table, depended, however, very much indeed upon the stage of growth at which the produce of the respective plots or crops was cut, and upon the condition of the weather at the time of cutting. Thus, the first crop of sewaged grass, particularly in the 5-acre field, was, for the most part, too ripe when cut, and hence the very large relative proportion of dry substance which on the average it contained. Again, in both fields, a considerable portion of the second crop of the unsewaged grass was much riper when cut than that of the sewaged. On the other hand, some of the crops, especially portions of the third and fourth, were cut and sampled in a very wet condition, and to this, in a certain sense,

* "These samples were taken before June 20, and were, by mistake, weighed with scales not sufficiently accurate for the purpose; the results are, therefore, given separately."

accidental, though unavoidable circumstance, must be attributed the very low proportion of dry substance found in some cases.

"The general result was, that the animals which had the unsewaged grass received considerably more dry or solid substance in a given weight of the fresh produce than those which had the sewaged grass. Hence, though the oxen on unsewaged grass consumed much less of the fresh food in relation to their weight than those on the sewaged, they nevertheless took into their stomachs quite as large a proportion of real dry or solid matter as the others. The cows on the unsewaged grass consumed, however, even more of their fresh food, with its higher proportion of dry substance, than did those on the sewaged; and they, at the same time, gave a larger quantity of milk, almost exactly in proportion to the increase in the amount of fresh food consumed. But, as a given weight of the fresh sewaged grass contained considerably less dry or solid substance than an equal amount of the unsewaged, it resulted that considerably more milk was obtained from a given quantity of the dry or solid substance of the sewaged than of the unsewaged grass.

"The question arises, was there any difference in the composition of the dry or solid matter of the two kinds of grass such as may be supposed to account for the greater productiveness, at any rate in milk, of that from the sewaged land? The following Summary Table relates to this point.

"TABLE VIII.—Showing the mean Composition (per cent.) of the Dry Substance of the Grass produced without and with Sewage, and in each successive Crop.

FIRST SEASON, 1861.

	Without and with Sewage.				Each successive Crop.			
	Un-sewaged.	Sewaged.			1st Crop.	2nd Crop.	3rd Crop.	4th Crop.
	Plot 1.	Plot 2.	Plot 3.	Plot 4.				
Number of Analyses } giving the means . . . }	5	7	9	9	11	9	7	5
Nitrogenous substance } (N \times 6.5) }	13.08	18.67	18.92	19.78	10.23	18.07	23.76	28.25
Fatty matter (ether extract) }	3.21	3.54	3.53	3.44	3.01	3.60	2.65	3.84
Woody fibre }	28.80	29.34	30.15	29.13	30.80	28.45	28.50	28.60
Other non-nitrogenous substances }	45.66	37.09	35.94	35.92	47.79	38.28	30.84	24.57
Mineral matter (ash) . .	9.25	11.36	11.46	11.73	8.07	11.60	13.25	14.74
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

"The figures in this table do indeed show a considerable difference in the composition of the dry substance of the unsewaged

and the sewaged grass; and those in the Tables of detail show that the great bulk of the produce varied more than the mere mean results here given would indicate.

"The chief point of remark is, that the solid matter of the much more luxuriant and succulent sewaged grass contained a considerably higher proportion of nitrogenous substance than that of the unsewaged. It also contained somewhat more, both of the impure waxy or fatty matter extracted by ether, and of mineral matter, which may be taken to indicate a less advanced or ripe condition at the time of cutting. But, owing to the generally less ripe and more succulent condition of the sewaged than the unsewaged grass, it is highly probable that a larger proportion of its nitrogenous substance was in an immatured condition; and, so far as it was so, it would be less available for the formation of the nitrogenous compounds of flesh or milk. It would at any rate be unsafe, without further evidence on the point, to attribute the higher milk-yielding quality of the dry substance of the sewaged grass unconditionally to its higher proportion of nitrogenous substance; and, it may be remarked that, according to such a rule, a given weight of the dry substance of the third and fourth crops should be very much more productive than an equal quantity of that of the first; for the Table shows that there was twice or thrice as high a proportion of nitrogenous substance in the solid matter of the crops grown late in the season as in that of those grown in the earlier and more genial periods of vegetation. Nor is the evidence at present at command such as to justify the conclusion that the superior milk-yielding quality of the dry substance of the sewaged grass is essentially connected either with its larger proportion of impure fatty, or of mineral matter. That the greater succulence of sewaged grass conduces at least to quantity of milk, experience seems to show; and that the constituents of its solid matter are in a readily convertible condition, the results of this first season's experiments on the question seem clearly to indicate.

"It remains to be seen how far the results of a second year's series of experiments, conducted with the greater attention to some points of detail which past experience suggests, will serve to confirm, modify, or further explain the conclusions to which the results given in this section seem to point.

"VI. Composition of the Milk yielded from the Unsewaged and from the Sewaged Grass.

"Once a week, during the greater part of the experimental period, the morning and evening milk of the two cows fed on unsewaged grass was mixed together, and a gallon sample of the

mixture taken. Samples of the milk from the ten cows fed on sewaged grass were taken in the same way. These samples were immediately put into bottles filled up to the corks and sealed down, and sent off the same evening by railway to Professor Way for analysis."

[There were in all 13 samples of the milk from the cows fed on unsewaged grass, and 15 of that from those fed on sewaged grass, taken as above described, and the results of the analyses of the 28 samples are given in the Appendix to the Report of the Commission.*]

"In the following Summary Table (IX.) are given,—the mean composition of nine samples of milk taken from the cows fed on unsewaged grass alone, and of ten taken from those fed on sewaged grass alone; the mean of four samples from each lot of cows during the concluding four weeks, when they had oilcake as well as grass; and also the composition of the milk of the ten cows taken on one occasion during the experiment, when, owing to a deficiency of the experimental grass at the time, they had, for a short time, a mixture of sewaged Italian rye-grass and clover, and a little oilcake besides.

"TABLE IX.—Mean Composition of the Milk, per Cent.

SEASON 1861.

	Cows fed on Grass alone.		Cows fed on Grass and Oilcake.		Cows fed on Sewaged Rye-grass and Clover, and Oilcake; 1 Sample.
	Unsewaged; Mean of 9 Samples.	Sewaged; Mean of 10 Samples.	Unsewaged; Mean of 4 Samples.	Sewaged; Mean of 4 Samples.	
Casein	3·246	3·241	3·352	3·423	3·125
Butter	3·604	3·430	3·657	3·707	3·473
Sugar of milk, &c. ..	4·405	4·218	4·561	4·689	4·700
Mineral matter ..	0·753	0·776	0·740	0·771	0·752
Total solid matter	12·008	11·665	12·310	12·590	12·050
Water	87·992	88·335	87·690	87·410	87·950
	100·000	100·000	100·000	100·000	100·000

"There is apparently but little difference between the average composition of the milk yielded from the unsewaged and the sewaged grass, whether they be respectively consumed alone, or

* In the Appendix to the Report of the Commission will also be found the results of the analyses of the individual samples of grass, and the details of the sewage applied, the produce of grass obtained, and of the food consumed, and milk and increase yielded by the animals.

in conjunction with oilcake. That from the sewaged and more succulent grass is slightly more aqueous, and contains slightly less of the organic constituents—casein, butter, and sugar of milk—and slightly more of mineral matter, during the early part of the season, when the cows had grass alone; but these relations are reversed during the four weeks when oilcake was given in addition. The addition of the oilcake, both in the case of the unsewaged and of the sewaged grass, but particularly in that of the latter, notably increased the proportion of the three organic constituents, and of the total solid matter of the milk, but somewhat diminished that of the mineral matter. Again, comparing the figures in the second and the fifth columns, those in the latter giving the composition of the milk when, for a few days only during the progress of the experiment, the diet of the cows was changed from sewaged grass alone to sewaged Italian rye-grass and clover, with oilcake in addition, the influence of the oilcake is seen to be of the same kind as already alluded to—increasing generally the proportion of the organic constituents, and of the total solid matter of the milk, and diminishing somewhat that of the mineral matter.

“ CONCLUSIONS.

“ Subject to the reservations which have been indicated, the results of the first season's experiments may be briefly enumerated as follows:—

“ 1. By the application of large quantities of dilute town sewage to permanent meadow land during the spring and summer months, there was obtained an average increase of about 4 tons of green grass (which, owing to the lower proportion of dry substance in the sewaged grass, was equal to only about three-fourths of a ton of hay) for each 1000 tons of sewage applied, until the amount of the latter approached the rate of about 9000 tons per acre per annum. The largest produce obtained was about 33 tons of green grass per acre. The period of the year over which an abundance of green food was available was, with the largest amount of sewage, between five and six months.

“ 2. Oxen tied up under cover, and fed on cut green grass alone, whether sewaged or unsewaged, gave a far lower rate of increase than the average attained by animals fed on ordinary good fattening food; but when for a few weeks oilcake was given in addition to the grass, they yielded a good average rate of increase.

“ 3. Cows tied up under cover, and fed on cut green grass alone, after previously receiving oilcake, fell off considerably in their yield of milk, and about equally whether the grass were sewaged or unsewaged. The cows on unsewaged grass consumed

more food and gave more milk, in relation to their weight, than those on sewaged grass; but the amount of milk yielded for a given amount of fresh food consumed was almost identical in the two cases; though, in proportion to the dry or solid matter which the food contained, the sewaged grass yielded considerably more milk than the unsewaged. Milk to the gross value of 32*l.* per acre was obtained where the largest quantity of sewage was applied. The gross value of the milk from the increased produce of each 1000 tons of sewage was between 5*l.* and 6*l.*

"4. The composition of the Rugby sewage-water varied very much during the course of the season, being much more concentrated during the drier months. On the average, over about seven months, 1000 tons of sewage contained about 21½ cwts., or little more than one ton of solid matter; about 212 lbs. of ammonia, or about as much as is contained in 11 cwts. of Peruvian guano; and probably represented the excrements of 21 or 22 individuals of a mixed population of both sexes and all ages for a year. This average composition agrees very closely with that which published analyses indicate for the sewage of London.

"5. On the average the sewaged grass contained, as cut, a considerably lower proportion of dry or solid substance than the unsewaged; but the dry substance of the sewaged grass generally contained a higher proportion of nitrogenous compounds.

"6. Analysis shows very little difference in the quality of the milk yielded respectively from sewaged and unsewaged grass. The difference in composition, such as it is, is slightly in favour of the milk from the unsewaged grass when grass was given alone, and slightly in favour of the sewaged grass when oilcake was given in addition."

Nothing has tended more to prevent a proper understanding between town and country—the producers of sewage and the consumers of manure—as to the commercial value of sewage, and the best manner of utilising it, than the very exaggerated statements which are from time to time put forth on the subject. Only a few weeks ago an *anonymous* pamphlet, pretending to be in the interest of the urban rate-payers, was published, which quotes an estimate, professedly founded on scientific authority, that the sewage of London, reckoning the prospective population at 3,000,000, will be worth something over 10,000,000*l.* sterling per annum! It required an expenditure of, I believe, 60,000*l.* to satisfy those who some years ago insisted upon the very high agricultural value of solid manure obtained from sewage by lime, that the value assigned to it by myself, and others, was correct. At

present there are no advocates for the manufacture of a solid manure from dilute town sewage. The controversy now lies between those who would distribute it in small quantities over enormous areas, and apply it to all crops, and those who would employ it in large quantities over comparatively small areas, and confine its application almost exclusively to succulent crops.

As already referred to, the "Select Committee on the Sewage of Towns" in their "Analysis of Evidence" give it as their opinion "that sewage is applicable to all crops, and that if commercial results are sought for, it should be applied in small dressings." I have very carefully considered the evidence given before that Committee, and I must confess that neither can I endorse the opinion just quoted, nor do I think there are many acquainted with agriculture who will think it borne out by the evidence when they have themselves perused it.

I have not the slightest doubt that any attempt to apply the sewage of London in its present average state of dilution, or that of any other town similarly diluted, to crops generally, and in quantities of a few hundred tons per acre, will result either in great pecuniary loss to those who invest their capital in supplying the sewage, or in signal failure, and perhaps pecuniary loss also, to those who, like Mr. Campbell, Mr. Congreve, and Mr. Mullins, the Rugby tenants, may purchase it for distribution in the manner proposed.

On the average, one ton of the sewage of London or Rugby contains only from 2 to 3 lbs. of solid matter, of which only about half, or less, will consist of the valuable constituents of human excrements; and with the progress of sanitary arrangements as at present generally carried out, the dilution appears to be daily increasing. It will be quite obvious, at any rate to most agriculturists, that the fact of having to bring upon the land such an enormous quantity of water in order to supply such a small amount of manurial matter, must materially affect the applicability of such manure to land under tillage, the cost at which a given amount of constituents can be brought on to the land, and their productive value when there. In fact, it is clearly quite fallacious to assume the general applicability to all crops, of manure so diluted, from any considerations as to the applicability of the same constituents in the undiluted form.

The agriculturist would, indeed, only be justified in contracting for a supply of town sewage at a price far below the estimates of those who propose to deliver it to him; and, taking into consideration not only the great, but the varying, and perhaps increasing dilution of sewage, the question of the composition as well as the amount of the sewage supplied, must form

the basis of any contract between town and country in the matter. The amount of nitrogen in sewage, in the forms of ammonia and nitric acid, affords the best indication of the amount of human excrements it represents, and hence it is the best guide as to the probable amount of the other valuable constituents. The relative value of the sewage might, therefore, be estimated according to the average number of grains of ammonia per gallon.

The question now at issue, it must be remembered, is not whether the constituents of human excrements, if presented to us in a concentrated, dry, and portable form, might not then be applicable to all crops, to those under tillage designed to ripen their seeds, as well as others, but whether those same constituents distributed through enormous bulks of water, as under the present, and rapidly extending system, can be so applied?

No one will doubt that if the sanitary requirements of the nation could be attained by any system which would preserve the excrements of the population free from admixture with water, and present them for use, at once undiminished in value by decomposition, and in a portable and innoxious condition, the land of the country devoted to the growth of human food might, by their application to it, be greatly increased in its productiveness.

The question of the sanitary arrangements of our towns was taken up by engineers before agricultural chemistry was much studied, and they have committed us to plans which, though they effectually remove the noxious matters from our dwellings, must greatly limit the area, and mode of their agricultural utilisation; and which, at the same time, have tended greatly to the pollution of our streams. To say nothing of the enormous cost that would be involved in entirely subverting the present methods of removing the excrements of the inhabitants of our large cities from their dwellings, it must be admitted, that no feasible scheme has yet been proposed by which this could be accomplished without the use of water. Such is certainly a great desideratum; but perhaps a consummation more to be wished than expected.

It is, perhaps, more probable, that by a reduction in the water supply, or by a more effectual separation of the sewage from the rain-fall, town populations may succeed in producing for the use of the farmer a less diluted sewage. But, in the mean time, we must deal with the sewage as we find it; and the price which the farmer could afford to pay for it would certainly offer no inducement to capitalists to invest their money in distributing it in small quantities over extensive areas. The only persons benefited by such a scheme, would be the contractors, and others, engaged in carrying out the undertaking.

APPENDIX. TABLE I.
 "Results of the Analyses of 12 Samples of Sewage-water collected in the Five-acre Field. SEASON 1861."

GRAINS PER GALLON.															
Sample numbers . . .	April.				May. Apr 29 to May 4.	June.			July.			August. 8-10	Sept. (9)	October. (15)	General Mean; 12 Samples.
	1-6	15-20	22-27	Mean.		11-15	17-22	24-29	Mean.	(9)	(15)					Mean.
	1	2	3		4	5	6	7		8	9		10	11		12
Organic matter { In solution . In suspension . Total .	Grains. 9-10 3-90	Grains. 8-64 1-76	Grains. 8-10 17-70	Grains. 8-61 7-79	Grains. 9-90 12-30	Grains. 8-70 13-70	Grains. 11-30 13-30	Grains. 11-10 11-90	Grains. 10-37 14-63	Grains. 12-20 10-90	Grains. 10-20 16-20	Grains. 11-20 13-53	Grains. 9-70 10-50	Grains. 12-20 64-40	Grains. 12-05 19-70
	13-00	10-40	23-80	16-40	22-20	27-40	24-60	23-00	23-00	23-10	26-40	24-75	20-20	76-30	31-75
	30-40 2-70	24-96 2-24	31-70 8-90	29-02 4-61	33-20 6-40	34-80 14-30	38-10 8-10	35-70 12-60	36-20 11-67	36-40 11-00	38-10 17-10	38-75 14-05	44-20 5-60	49-30 90-90	47-80 14-30
Inorganic matter { In solution . In suspension . Total .	33-10	27-20	40-60	33-63	39-70	49-10	46-20	48-30	47-87	46-40	53-20	49-80	49-90	140-20	62-10
	46-10	37-60	66-40	50-03	61-90	76-30	70-80	71-30	72-87	69-50	79-60	74-55	70-10	216-50	93-85
Total solid matter . .	2-59 0-40	2-88 0-49	3-08 1-27	2-85 0-72	2-69 2-28	4-43 1-59	5-14 0-90	4-89 1-37	4-72 1-25	4-23 0-93	4-78 1-24	4-35 1-09	5-40 1-90	10-57 5-07	9-42 2-40
	2-99	3-37	4-35	3-57	5-08	6-02	5-94	5-96	5-97	5-25	6-02	5-64	7-20	15-64	11-82
Phosphoric acid { In solution . In suspension . Total .	0-86 0-64	..	..	..	1-37 1-09	..	..	..	..	..	..	..	..	..	..

APPENDIX. TABLE II.

“Results of the Analyses of 12 Samples of Sewage-water collected in the Ten-acre Field. SEASON 1861.

GRAINS PER GALLON.																		
April.				May.	June.				July.			August.	Sept.	October.	General			
1-6		15-20	22-27	Mean.	April 29 to May 4.	11-15	17-22	14-29	Mean.	(9)	(14)	Mean.	5-10	(9)	(15)	Mean; 12 Samples.		
Sample numbers . . .																		
Organic matter {																		
In solution .																		
In suspension .																		
Total .																		
Inorganic matter {																		
In solution .																		
In suspension .																		
Total .																		
Total solid matter . .																		
Ammonia {																		
In solution .																		
In suspension .																		
Total .																		
Potash																		
Phosphoric acid																		

V.—*On the Supply of Horses adapted to the Requirements of the English Army; with Notes on the Remount System in the French Army.* By J. WILKINSON.

IN the history of the horse, it would be interesting to trace the changes which time, climate, and the control of man have effected in the animal's frame and constitution. To the colossal fossil remains which have been discovered in America, no exact date can be assigned; but they are evidently those of a gigantic race long since extinct, which differed essentially from that now on the earth. If we would learn what was the prevailing type of the horse of the early Asiatic empires, a wonderfully faithful record has been preserved in the Nineveh marbles; whilst the sculpture and painting of Greece and Rome will enable us to form as true a conception of the then existing type, making due allowance for the exercise of poetical imagination in those works of art. In the ever-varying and ever-beautiful form and character of the figures represented by these artists, a harmony prevails from which we may fairly conclude that the conformation is, as a whole, true to nature.

Some important "points" which we recognise in the Elgin Marbles, and the various antiquities of the Acropolis, have been successfully and rightly reproduced in modern works, such as the beautiful bas-relief of the "Passage of the Red Sea" in the last Great Exhibition, and are still to be traced in one or two extant breeds of north-western Europe; points especially affecting the head, neck, and body, and exhibiting a configuration which we in England by no means seek to imitate.

In respect of numbers, although the horses and chariots of the Egyptian and Asiatic monarchies were numerous, it was reserved for Tamerlane and Bajazet to assemble the most mighty hosts on record, when between them they paraded 700,000 horses! The requirements of modern European armies are dwarfed by such a comparison, and our own numbers are small even when compared with those of some continental nations; but the ordinary demands of our peace establishment of 13,000 or 14,000 horses by no means indicate the amount of strain which would be put on our resources in the event of war.

In ordinary times the proportion drafted from the service is a little under 13 per cent., or about 1500, a number which bears a very small proportion to the whole supply bred for the English market. Of these 13 per cent. a little over 11 per cent. are *cast* and sold, the deaths from accidents and incurable diseases being less than 1 per cent., and those resulting from curable diseases of a like amount.*

* In the chapter of accidents, the following are noteworthy. A short time ago a man in a leading charging squadron had his lance wrested out of his hand, so

For these favourable results we are indebted, in the first instance, to the vigilance and practical skill of His Royal Highness the Field-Marshal Commanding-in-Chief, who expects every branch of the service to be "always ready," and at once detects any defect, whilst he so encourages and supports every zealous officer as to make the performance of duty a real pleasure.

In the second place, these results are due to the exertions of all the officers and men of the various regiments, who constantly vie with one another in the practical application of the best means of keeping horses in health. These means are so correctly appreciated in the army, and are so few and so simple, that they can be easily carried out. Good oats, 10 lbs. per diem; hay, 12 lbs.; straw, 8 lbs.; water, *ad lib.*; exercise; surface drains; clean stables, dry litter floors, and proper ventilation. The system of ventilation is threefold:—1st. Ground ventilation—for drying the floors; 2ndly, ceiling ventilation—for the egress of vitiated air; and lastly, but not least, respiratory ventilation—for the supply of fresh air under the horse's nose; all these ends being accomplished without the creation of strong currents. It will easily be seen that our principles of stable management are founded on common sense.

These results contrast very favourably with the comparative military statistics of our neighbours the French. They muster an effective force of about 41,793 horses of all arms of their service, and the average of deaths is $8\frac{1}{2}$ per cent. (instead of about $1\frac{1}{2}$), namely—5 per cent. from glanders and farcy, and $3\frac{1}{2}$ per cent. from accidents and what we have designated curable diseases in contradistinction to those which defy all medical skill.

For many years there has not been any very important change in the characteristics of the horses required for the army on home service. They may be appropriately divided into two chief classes—those of the Cavalry and the Artillery: the first of which may be subdivided into Heavy and Light Cavalry; the second into Horse and Field Artillery; the requirements of the Engineers and Military Train being put under the same head as those of the Field Artillery, although the Engineers use a rather smaller horse, and the Military Train a slightly heavier one, than the Field Artillery. Each corps selects its own horses.

that it fell upon its butt, and pointed backwards. A horse in the succeeding squadron caught the point on his breast, and so completely impaled himself on it, that it came out close to his tail. Again, the other day two horses whilst at drill, approaching each other from opposite directions, came into collision, and the combined force was so great as to fracture the skull of one and break the back of the other. The horses could not fail to foresee the shock, and, but for their docility, might have avoided it. And yet we are expected to doubt the power of cavalry to break a square of infantry!

The Heavy Cavalry make, in a great degree, successful attempts to procure the breeding and substance of weight-carrying hunters. The Light Cavalry attempt with equal success to obtain well-bred, active, hunting-like horses of less weight.

Those chosen for the Horse or Flying Artillery approximate more to the London carriage horse than to any other class; and those which belong to the Field Battery class, are of the thick, active farm or railway-contractor's kind. The officers' chargers, being suitable for the park or hunting-field, and such as they would use whether in the army or not, need not be further noticed.

This classification may be said to have existed for a good many years, but the number in each class has not remained relatively the same; the Royal Artillery having been greatly augmented in consequence of the increased importance of that arm of the service.

Although in no one instance, perhaps, is a horse bred expressly to supply the army, nevertheless horses of all these four descriptions are reared in abundance in the United Kingdom; and we may feel assured, from our experience of the influence of the short Crimean campaign, that our general capability of rearing horses admits of very great expansion. Under the impulse then given, in Ireland alone the increase in one year, upon a stock of 573,408, amounted to 26,374; as although the war was then over, the vastness of this increase may be attributed to its influence. It is very much to be regretted that we have no means of knowing how many were bred in Great Britain in the same eventful period; for we may be allowed to think that the diminution in the number of cavalry horses bred in Great Britain, which is a notorious fact, and the increase of the same produce in Ireland, have arisen in no inconsiderable degree from the publicity which was given in Ireland and there only, to the state of the supply. Twenty-five years ago the case was reversed.

The price paid by Government for the horses of the army, which on an average amounts to about 36*l.*, may not at first sight seem to be sufficiently remunerative to induce farmers to breed purposely for the army, and such, perhaps, never is their precise purpose. Their aim is to breed a carriage horse or a hunter; but as their good intentions are not always realised, they sometimes fall back upon the cavalry or horse artillery. In breeding for farm or railway purposes, they at the same time produce horses for the rest of the service; and we think that 36*l.* for a green four-year old of this class would pay the farmer, if he obtained his fair share of the price paid; but we fear that more dealers live between the breeder and the barrack than is compatible with the interest of either party. Therefore the

supposed difference between the real value of the horse supplied and the 36*l.* which he costs, affords a base for the arguments in favour of Government breeding-establishments, and against the present system of remounting.

This question, which has engaged the attention of military men and others from time to time, has led to the framing of many well-considered schemes; but they have failed to carry with them the conviction that such a course would be better for the Government or the army than to have, as at present, the whole agricultural interest in the United Kingdom as an open market. At the same time we think it not impossible that some plan might be discovered by which the farmer would be better remunerated, and the troops as well, if not better, mounted.

The horse, as well as other animals, has been much improved by judicious crossing; but as every race has a natural tendency to return to its primeval type, constant attention is required on the part of breeders to prevent degeneration. Wonderful improvements in conformation, speed, and strength, have been accomplished in some classes. We may instance as specimens the statue opposite Apsley House (*when seen on the ground*) and that in Pall Mall East. Both these we have reason to believe were taken from life. But, alas! the majority of breeders pay very little attention to symmetry and power. Sometimes they do not appear to have any purpose in breeding beyond the getting of a foal of any sort. Some are so prejudiced that they will breed from a mare when old and worn out, simply because she once carried her owner through a very long journey, or performed some other unusual feat; entirely disregarding the fact that she may have a large head, ewe neck, upright shoulders, calf knees, long crooked pasterns, long slack back, weasel waist, short drooping quarters, short thighs, curby or cow hocks, with dish-ing speedy cutting, or slouching action.

The selection of the sire will likewise be mainly determined by the small cost of service or a long pedigree; though to the intrinsic merits of his race, he may exhibit no personal claim whatever. A mongrel offspring is the result, and the breeder is led to the exercise of his British prerogative, and grumbles, not at his own mismanagement, but at what he calls capricious nature, which drops a valuable foal in a neighbour's paddock on the other side of his boundary fence.

The farmer will not breed expressly for the army, but aim at getting either a weight-carrying hunter or a carriage-horse, with the further chance of receiving from 30*l.* to 36*l.* for his colt at four years old, for military service—no very bad alternative.

When we take into consideration the wonders achieved of late years in our improved races of cattle, sheep, and pigs—their

early maturity, their precocity in breeding—it is surprising that the same principles have not been generally applied to the horse, and attended with like results. In breeding for the turf alone has the new system been in any degree adopted. From the high and forcing diet afforded to the young thoroughbred he has often, to all intents and purposes, as much arrived at maturity at four years old as the colt which has run loose on wild pastures at five. He is thoroughly furnished, and his bones are quite consolidated. In one respect only it would seem that Nature's course cannot be accelerated, viz., the development of the teeth. Whatever be the extent to which the young thoroughbred is forced, the dentition will not be forestalled, but the mouth will give a correct indication of his age. This circumstance promotes trickery among the breeders and dealers, which often produces prejudicial consequences; but from high-feeding the young colt will now not only have a more fully developed frame, but greater fitness to stand work than he would generally get credit for if his age were honestly indicated by his teeth. This circumstance may explain, but not excuse, the cruelty to which young horses are so often exposed from extraction of milk teeth and cauterising the gums and other such expedients to hasten the process of teething. It would seem, then, that early maturity is as attainable in the horse as in other animals, and that, not in appearance and stature only, but in fitness for bearing the strain of work. The same means will here be required which have been found so profitable in the case of cattle, viz., a generous diet, such as proves remunerative not only in the market but in the manure-heap. If such a course be adopted, the breeding of horses need no more be restricted to the pastures of Yorkshire and similar districts than the breeding of shorthorns to the birth-place of that tribe; and special advantages from easy and convenient access to good sires may counterbalance the possession of better natural feeding-grounds.

The most prevailing defect among horse-breeders is a want of sufficient care in procuring good mares to breed from. One method of securing a satisfactory dam may be safely recommended. Suppose some fairly satisfactory mares have thrown fillies (which is generally a disappointment), let these be well-fed, and put to the horse at three years old. Experience will soon enable you to decide between them which is best adapted to become a permanent brood-mare. Each one of them will give you a tolerable foal to pay for her keep, and will herself have gained in frame and substance; her year of repose will have much more than compensated for the healthy demand made upon her constitution by bearing and rearing the foal. The less satisfactory mares will then be of the right age to be sold

for the military service, for which more mares than horses are purchased for the cavalry, though in the artillery a gelding has more decidedly the preference.

With other stock, that desideratum, an increase in price, seems to be at once responded to by improved supplies; and we feel at a loss to account for the exceptional supineness or want of skill which cannot be tempted even by that bait to the display of more energy in horse-breeding.

If the farmer were more successful, his better fortune would be reflected upon the mounted part of our army, for the raising of the value of his produce would inevitably lead to an advance in the Government allowance; and although we do not suppose for a moment that his produce would ever sell for the factitious prices (ten to fifteen hundred guineas each), which are realised at one or two of the annual sales of blood stock, yet we think that by more attention to conformation, action, and age in the parents, and by the discontinuance of the practice of leaving the produce, when weaned, to eke out an eleemosynary subsistence on the marsh or moorside, breeding horses for general purposes might be made a more profitable occupation than it appears to be at present.

Mistakes sometimes arise because the quality of a horse is thought to be discovered whilst he is yet very young, and he is either pampered or half-starved according as he may be considered prospectively capable of splitting a Leicestershire "bullfinch" or an enemy's squadron. And hence the cavalry often gets a thin horse, which, when properly nurtured in a regiment, develops qualities that, as the "best-mannered horse" in a crack dealer's hands, would swell the tens he cost into hundreds.

The Remount System in the French Army.

The state of the market for horses in France differs very materially from our own, the State being there not only a more important customer, but having entered into, or forestalled competition to some degree as a breeder. Of the Royal Establishments of brood-mares formed some years back, some have of late been abandoned, and others restricted or threatened with dissolution—probably from the results produced not answering expectation; and the Government seems more and more disposed to rely on the general market for a supply, and to encourage it by a steady system of purchase rather than by direct subsidies.

The following information condensed from an official report on the Remount System in the French Army may afford some useful hints for our own consideration. In France, as among our-

selves, the general insufficiency of the supply is complained of, and an explanation found in the fact that the price of the horse has not risen in the same proportion as that of the bullock.

On this point Count Roche Aymon wrote as follows in 1828: "Before 1791, 400 or 500 francs was paid for a Limousin horse two and a-half years old, and a pair of oxen were sold for from 300 to 400 francs. Nowadays these oxen are sold at from 700 to 800 francs each, and horses four or five years old sell for 400 or 500 francs," and it is remarked that if these figures are not quite correct, yet their proportions are preserved in the returns of actual commerce. There is, therefore, more advantage in producing horned beasts than riding-horses.

The insufficiency of the supply is no new complaint, since in the time of Colbert one hundred millions of pounds were exported to pay for horses, and proportionally as much since that period.

The deficiency is by no means equally distributed between the different classes required for the use of the army; for, whilst artillery horses and mules for draught, finding always a steady market, independent of the Government, for home use or even for export, are always in fair supply without any special encouragement (and indeed in spite of the attempts made to foster other breeds exclusively) of riding-horses,—such as are required for light cavalry, there never is much choice. The French generally are not a riding and driving community like ourselves, therefore the number of saddle-horses there bred will chiefly depend on the encouragement given by the requirements of the army, and on the sufficiency of the price there paid to meet the average cost and risks of the breeder. Much stress is therefore now laid by some of their authorities on regulating the Government demand, and, if possible, announcing beforehand its probable extent. It has fluctuated from 20,000, 30,000, 40,000 in a year, to scarcely more than 2000 or 3000, and it is asked if the breeders have on hand and wish to sell 12,000 or 15,000 riding-horses in a year when the State, as we have seen, may only purchase 500 or 1000, what is to become of the others? "The coach-contractor prefers for his work a Percheron horse at 1000 francs to a saddle-horse (Merlonese) at 6000 francs, or a Breton horse at 500 francs to a Limousin at 10,000. Therefore, horses designed for the cavalry cannot be sold for other purposes without loss to the breeder.

The guarantee of a steady rate of purchase—say of 7000, 8000, or 9000—for the army, is, therefore, essential to the supply being forthcoming; and it is suggested that the existing establishments of horses had better be weeded occasionally, than the rate of pur-

chase made to vary much. Such weeding would remove inefficient and sickly horses, and be in that respect economical.

It is further urged that the saddle-horse is necessarily an expensive animal to rear, because its dam does little work, it must have oats to eat, often meets with accidents, and these accidents depreciate its value; the successful colt must therefore be got up in such a form that it may fetch a price which shall cover the losses incurred in the case of failure. The price, therefore, cannot be low if it is to be moderately remunerative.

A plan for having "depôts for foals," which the State is to purchase when young, and then entrust to farmers to be reared at the expense of the State, is wisely rejected in the Report in question.

It would seem, then, that the French Government, dissatisfied with its attempts at breeding, is disposed to trust for its supply of riding-horses to the general market, when encouraged by a regular demand and a fair price.

Assuming, then, that the remount is to be procured in the general market, the question remains—what is the agency to be employed in making purchases? We are told that "The employment of large contractors to furnish horses is a most vicious method, for how can any one foretell the value and the prospect of an abundant supply of horses? It is an undertaking which either ruins the contractor or makes his fortune; but as the purveyor always knows how to arrange matters so as not to lose in the transaction—for those charged to receive the horses will accept very middling or even bad animals rather than see an unfortunate speculator lose his fortune in the service of the State—the army is always more or less the sufferer; at all events, it is preferable by direct purchases to allow the breeders to have a profit rather than these dealers."

The purchase by regiments is preferable, but each regiment ought only to buy horses from its own immediate neighbourhood. The mere presence at a distant fair of strangers bent on purchasing, raises prices, and if the opportunity is not favourable a long journey will have been incurred to no good purpose.

The establishment, therefore, of permanent remount depôts in the most favoured and central districts is advocated, that the officers commissioned to purchase, may be in contact with the breeders without any intervention of commissioners or dealers. It is contemplated that they would make purchases for each branch of the service indiscriminately within their district, although generally each province or department will have its peculiar stamp of horse, whether suited to the artillery or the cavalry.

These dépôts would not only purchase, but handle and train the horses, before sorting and apportioning them among the different corps. It is expected that, in the breeding districts, the supply of forage will be cheap and ample, and that the young horse, during his course of training, will be least exposed to sickness in his native country.

It is considered more prudent to appoint a commission than to employ for purchase a single agent, who might bear a grudge against some particular breeder.

Purchases might be made at the principal fairs or at the breeders' homes, but a complaint is made that certain breeders are not so frank and are more given to imposition than the dealers.

Although the services of a contractor be not specially engaged, horses might sometimes be bought through dealers who have a ready access to secluded districts and farmers who follow the old routine of sale.

In every dépôt there ought to be a register in which a page should be assigned to each breeder in the district, wherein to notify the number of horses furnished by him, and the arm of the service for which they were intended.

With due provision and encouragement, it is considered that Normandy and Brittany alone might furnish 4000 or 5000 horses yearly,—a large portion of the average supply required.

The French prices for 1851, 1852, and 1853 were as follows :—

PRICE AND HEIGHT OF FRENCH TROOP-HORSES.

Branches of the Service.	Height.	Official Price.	Mean Purchase-price in					
			1851.		1852.		1853.	
	Hands.	£.	£.	s.	d.	£.	s.	d.
Reserve	15·2 to 15·3	32	31	0	0	32	0	0
Cavalry of the Line ..	15 to 15·2	26	26	14	0	26	0	0
Light Cavalry	14·3 to 15	22	22	18	0	23	2	0
Cavalry in Africa ..	..	14	14	13	4	14	0	0
Manège (Riding-school) and horses in training/	..	40	42	6	8	51	10	0
Officers' chargers ..	..	36	38	0	6	36	6	0
Ditto in Africa .. ..	..	20	20	15	6	26	0	0
<i>Artillery :</i>								
Riding .. .. .	..	26	..	..	..	18	0	0
In Africa .. .. .	..	..	12	12	0	..	..	..
Draught-horses ..	15 to 15·2	22	27	12	0	..	..	..
Mules	14·3 to 15·1	20	..	..	..	..	..	..
Donkeys .. .. .	..	8	..	..	..	..	..	..
Camels .. .. .	..	8	..	..	..	..	..	..

VI.—*Experiments with different Top-Dressings upon Wheat.*

By DR. AUGUSTUS VOELCKER.

IN Vol. XX., Part II., and Vol. XXIII. of this Journal, reports will be found of experiments made by me in 1859-60-61, with top-dressings upon wheat. I have now the pleasure of laying before the Society a short account of similar wheat experiments made in 1862.

WHEAT EXPERIMENTS MADE IN 1862.

The field on which the wheat was grown is well drained, moderately stiff, and on the whole fair wheat-land. The depth of the surface-soil varies from 6 to 8 inches.

A large quantity of the soil from the experimental field (fields Nos. 16 and 17 on the map of the Royal Agricultural College Farm) was turned over and well mixed, so as to obtain a fair average sample for analysis, which gave the following results :—

Composition of Soil in Field No. 16 and 17, Royal Agricultural College Farm.

Moisture (when analysed)	..	..	..	..	..	2.71
*Organic matter and water of combination	..	..	..	..	..	10.90
Oxides of iron and alumina	..	..	..	..	..	16.11
Carbonate of lime	..	..	..	..	..	17.43
Sulphate of lime	..	..	..	..	..	.23
Magnesia	..	..	..	..	..	1.75
Phosphoric acid	..	..	..	..	..	.11
Chlorine	..	..	..	..	..	traces
Potash	..	..	..	..	..	.86
Soda	..	..	..	..	..	.91
Insoluble siliceous matter (clay)	..	..	..	..	..	49.44
						100.45
*Containing nitrogen	..	..	..	..	..	.38
Equal to ammonia	..	..	..	..	..	.46

This soil contains hardly any siliceous sand separable by the mechanical process of washing and decantation, and consists principally of clay, carbonate of lime; and organic remains. It is a calcareous clay.

The subsoil is a mechanical mixture of stiff yellow clay with limestone rubble resting on forest-marble rock. On analysis it furnished the following results :—

Composition of Subsoil in Field No. 16 and 17, Royal Agricultural College Farm.

Moisture (when analysed)	1.34
*Organic matter and water of combination	8.07
Oxides of iron and alumina	21.68
Carbonate of lime	36.76
Sulphate of lime	.32
Magnesia	.27
Phosphoric acid	.16
Chlorine	traces
Potash	.56
Soda	.72
Insoluble siliceous matter (clay)	30.57
	<hr/> 100.45
*Containing nitrogen	.34
Equal to ammonia	.41

This field is perfectly level, and the soil, as far as could be ascertained, uniformly deep. Its extent is 16 acres 11 poles. It was cropped in preceding years as follows:—

- 1857. Cow-grass, mown and fed.
- 1858. Wheat.
- 1859. Mangolds, potatoes, cabbages.
- 1860. Oats.
- 1861. Vetches, followed by white swedes and grey-top stone turnips.
- 1862. Free trade wheat and seeds.

This field generally grows good clover.

Two acres covered with a tolerably equal plant were measured out, and carefully divided into 8 equal plots of $\frac{1}{4}$ acre each. They were surrounded by a considerable breadth of the general wheat-crop. These 8 plots, with the exception of plot No. 5, which was left unmanured, were top-dressed as follows:—

Plot.	Top-dressing.	Rate of Dressing per Acre.	Cost per Acre.
I.	{ $\frac{1}{4}$ cwt. of nitrate of soda and $\frac{1}{4}$ cwt. of salt }	1 cwt. of nitrate and 2 cwt. of common salt }	£. s. d. 0 17 0
II.	{ 42 lbs. of nitrate of soda and 84 lbs. of salt }	1 $\frac{1}{2}$ cwt. of nitrate and 3 cwt. of common salt }	1 5 6
III.	{ $\frac{1}{4}$ cwt. of nitrate of soda and 1 cwt. of common salt .. }	2 cwt. of nitrate and 4 cwt. of salt }	1 14. 0
IV.	$\frac{1}{4}$ cwt. of nitrate of soda	2 cwt. of nitrate of soda	1 10 0
V.	Unmanured .. ..	.. ..	.. ..
VI.	84 lbs. of common salt	3 cwt. of salt	0 3 0
VII.	{ $\frac{1}{4}$ cwt. of Peruvian guano and $\frac{1}{4}$ cwt. of salt }	2 cwt. of guano and 2 cwt. of salt }	1 8 0
VIII.	$\frac{1}{4}$ cwt. of Peruvian guano	2 cwt. of Peruvian guano	1 6 0

The cold and wet spring of 1862 prevented the wheat from

making a fair start early in the season. Before this takes place, if I am not mistaken, it is not desirable to top-dress wheat. No general rule can be laid down for this operation: in some seasons the end of February or beginning of March is not too early; but in average seasons it appears to me more desirable to delay the application until the middle or end of March, and in wet cold springs even to the middle of April; or, generally speaking, until warmer and more settled weather has given a fair start to the wheat-plant.

In 1862 the top-dressings were delayed until the 15th of April. Before being sown broadcast with Reeve's dry manure-distributor, they were passed through a fine sieve, and, in order to secure a more uniform distribution over the land, mixed with fine coal-ashes.

It will be seen that I confined my attention to three fertilizers only, namely, to nitrate of soda, Peruvian guano, and salt.

In the three preceding seasons nitrate of soda had invariably produced a beneficial practical result, both applied alone and in conjunction with salt.

One of the objects of the experiments in 1862 was to ascertain in what proportions nitrate of soda is most economically applied as a top-dressing for wheat. For this purpose 1, 2½, and 3 cwt. of nitrate of soda per acre were used in 3 experimental plots, and in each case the nitrate of soda was mixed with twice its weight of common salt.

On Plot IV. nitrate of soda alone, at the rate of 2 cwt. per acre, was employed to afford a comparison with the adjoining plot, on which the same quantity of nitrate of soda was used mixed with twice its weight of salt.

In 1860 salt alone gave no appreciable increase of wheat: in 1861 it had a decidedly beneficial effect. A continuation of the experiment, therefore, seemed desirable, and accordingly salt alone was tried on Plot VI., applied at the rate of 3 cwt. per acre.

In Plots VII. and VIII. Peruvian guano was applied alone and together with salt, to test the real advantage of the latter mixture.

Plot I.—Top-dressed April 15th, 1862, at the rate of 1 cwt. of nitrate and 2 cwt. of salt, produced:—

									cwt.	qrs.	lbs.
Corn, Head	..	..	..	..	..	..	..	..	5	0	15½
„ Tail	..	..	..	..	..	..	..	..	0	0	6½
									5	0	22
Straw	..	..	..	..	..	..	..	..	6	1	6
Chaff	..	..	..	..	..	..	..	..	0	1	8
Cavings	..	..	..	..	..	..	..	..	0	0	18

Produce per acre:—

Corn (head and tail) 38 bushels 48 lbs., calculating 60 lbs. to the bushel.

Straw (including chaff and savings) 1 ton 7 cwt. 16 lbs.

The nitrate of soda was a good commercial sample, as will be seen by the following analysis:—

Composition of Nitrate of Soda used in these Top-Dressings.

Water	8.427
Chloride of sodium	1.184
Pure nitrate of soda	94.210
Sand and earth	1.179

100.000

Plot II.—Top-dressed April 15th, at the rate of $1\frac{1}{2}$ cwt. of nitrate of soda and 3 cwt. of salt per acre, produced:—

	cwt.	qrs.	lbs.
Corn, Head	5	2	6
„ Tail	0	0	2
	5	2	8
Straw	7	0	22
Chaff	0	1	11½
Cavings	0	0	16

Produce per acre:—

Corn (head and tail) 41 bushels 36 lbs., at 60 lbs. per bushel.
Straw (including chaff and cavings) 1 ton 9 cwt. 3 qrs. 2 lbs.

In comparison with Plot I., the higher produce here obtained both in corn and straw more than repaid the additional outlay for the extra quantity of nitrate of soda and salt.

Plot III.—Top-dressed, at the rate of 2 cwt. of nitrate of soda and 4 cwt. of salt per acre, produced:—

	cwt.	qrs.	lbs.
Corn, Head	5	3	10
„ Tail	0	0	18½
	6	0	0¼
Straw	7	1	23
Chaff	0	1	0
Cavings	0	0	23

Produce per acre:—

Corn (head and tail) 44 bushels 48 lbs.
Straw (including chaff and cavings) 1 ton 10 cwt. 2 qrs. 16 lbs.

A still more favourable result, then, was produced by adding again $\frac{1}{2}$ cwt. of nitrate of soda and 1 cwt. of common salt per acre to the quantity of the same top-dressing used in the preceding experiments.

Plot IV.—Top-dressed with $\frac{1}{2}$ cwt. of nitrate of soda alone, or at the rate of 2 cwt. per acre, produced:—

104 *Experiments with different Top-Dressings upon Wheat.*

								cwt.	qrs.	lbs.
Corn, Head	..	..	..	..	..	..	..	5	3	21
„ Tail	..	..	..	..	..	..	..	0	0	4½
								5	3	25½
Straw	..	..	..	..	..	..	..	7	2	21
Chaff	..	..	..	..	..	..	..	0	1	16½
Cavings	..	..	..	..	..	..	..	0	1	7

Produce per acre :—

Corn (head and tail) 44 bushels 38 lbs., at 60 lbs. per bushel.

Straw (including chaff and cavings) 1 ton 13 cwt. 1 qr. 10 lbs.

Nitrate of soda alone, in this experiment, gave almost exactly the same produce in corn and rather more straw than the same quantity of nitrate mixed with twice its weight of salt.

The wheat on all the plots to which nitrate of soda was applied looked remarkably well, and for the first three months had a brighter green colour than the wheat on the guano plots.

Plot V.—Unmanured, produced :—

								cwt.	qrs.	lbs.
Corn, Head	..	..	..	..	..	..	..	3	3	13
„ Tail	..	..	..	..	..	..	..	0	0	2½
								3	3	15½
Straw	..	..	..	..	..	..	..	4	3	2
Chaff	..	..	..	..	..	..	..	0	1	1½
Cavings	..	..	..	..	..	..	..	0	0	22

Produce per acre :—

Corn (head and tail) 29 bushels 2 lbs.

Straw (including chaff and cavings) 1 ton 3 qrs. 18 lbs.

The difference in the appearance of the wheat on the unmanured plot and that on the four preceding plots was very marked throughout the whole season. At harvest time the wheat on the unmanured plot was several inches shorter in straw, nor were the ears so long or so well filled as in the wheat on the nitrate of soda and guano experimental plots.

Plot VI.—Top-dressed, at the rate of 3 cwt. per acre, produced :—

								cwt.	qrs.	lbs.
Corn, Head	..	..	..	..	..	..	..	5	0	21
„ Tail	..	..	..	..	..	..	..	0	0	1½
								5	0	22½
Straw	..	..	..	..	..	..	..	5	1	2
Chaff	..	..	..	..	..	..	..	0	2	3
Cavings	..	..	..	..	..	..	..	0	1	0

Produce per Acre :—

Corn (head and tail) 38 bushels 50 lbs.

Straw (including chaff and cavings) 1 ton 4 cwt. 20 lbs.

The wheat on this plot looked rather stronger and more

Experiments with different Top-Dressings upon Wheat. 105

succulent than that on the unmanured plot, and, as the result showed, yielded a considerable increase of corn.

Plot VII.—Top-dressed April 15th, at the rate of 2 cwt. of guano and 2 cwt. of salt per acre, produced :—

								cwt.	qrs.	lbs.
Corn, Head ..	..	..	..	..	..	..	..	5	3	5
„ Tail ..	..	..	..	..	..	..	..	0	0	3½
								5	3	8½
Straw ..	..	..	..	..	..	..	..	6	0	16
Chaff ..	..	..	..	..	..	..	..	0	2	13½
Cavings ..	..	..	..	..	..	..	..	0	1	3

Produce per acre :—

Corn (head and tail) 43 bushels 30 lbs.

Straw (including chaff and cavings) 1 ton 8 cwt. 8 lbs.

The guano used in this and next experiment was genuine Peruvian of superior quality, as will be seen by the following analysis :—

Moisture ..	..	..	..	..	..	..	..	17	03
*Organic matter and salts of ammonia ..	..	..	..	..	..	..	..	52	04
Phosphates of lime and magnesia ..	..	..	..	..	..	..	..	19	61
Alkaline salts ..	..	..	..	..	..	..	..	10	43
Sand ..	..	..	..	..	..	..	..	89	
								100	00
*Containing nitrogen ..	..	..	..	..	..	..	..	14	94
Equal to ammonia ..	..	..	..	..	..	..	..	18	14

Plot VIII.—Top-dressed with Peruvian guano, at the rate of 3 cwt. per acre, produced :—

								cwt.	qrs.	lbs.
Corn, Head ..	..	..	..	..	..	..	..	5	2	24
„ Tail ..	..	..	..	..	..	..	..	0	0	3
								5	2	27
Straw ..	..	..	..	..	..	..	..	6	2	9
Chaff ..	..	..	..	..	..	..	..	0	2	19
Cavings ..	..	..	..	..	..	..	..	0	1	22

Produce per acre :—

Corn (head and tail) 42 bushels 52 lbs.

Straw (including chaff and cavings) 1 ton 10 cwt. 3 qrs. 4 lbs.

The whole produce from each $\frac{1}{2}$ acre under experiment was threshed out separately and carefully weighed. In stating the produce in bushels a uniform weight of 60 lbs. per bushel has been assumed; but in reality the corn on all the plots was lighter, and with little variation on the different plots weighed 58½ lbs. per bushel.

To facilitate a comparison, the preceding results are embodied in the two following tables :—

106 *Experiments with different Top-Dressings upon Wheat.*

TABLE I.—*Showing the Produce, in lbs. and bushels, of Corn on Experimental Plots, calculated per Acre, and the Increase per Acre over Unmanured Plot (calculating the weight per bushel at 60 lbs.).*

Plot.	Manure employed per Acre.	Produce in Corn per Acre.		Increase of Corn per Acre.	
		lbs.	bushels.	lbs.	bushels.
I.	{ 1 cwt. of nitrate of soda and 2 cwt. of common salt }	2328	38½	586	9½
II.	{ 1½ cwt. of nitrate of soda and 3 cwt. of common salt }	2496	41½	754	12½
III.	{ 2 cwt. of nitrate of soda and 4 cwt. of common salt }	2688	44½	946	15½
IV.	2 cwt. of nitrate of soda alone	2678	44½	936	15½
V.	Unmanured .. ..	..	29	..	..
VI.	3 cwt. of common salt	2330	38½	588	9½
VII.	{ 2 cwt. of Peruvian guano and 2 cwt. of common salt }	2610	43½	868	14½
VIII.	2 cwt. of Peruvian guano	2570	43	830	14

TABLE II.—*Showing the Produce in Straw per Acre, and Increase over Unmanured Plot.*

Plot.	Manure per Acre.	Produce in Straw per Acre.				Increase in Straw per Acre.			
		tons	cwt.	qrs.	lbs.	cwt.	qrs.	lbs.	
I.	{ 1 cwt. of nitrate of soda and 2 cwt. of common salt }	1	7	0	16	6	0	26	
II.	{ 1½ cwt. of nitrate of soda and 3 cwt. of common salt }	1	9	3	2	8	3	12	
III.	{ 2 cwt. of nitrate of soda and 4 cwt. of common salt }	1	10	2	16	9	2	26	
IV.	2 cwt. of nitrate of soda alone	1	13	1	16	12	1	26	
V.	Unmanured	1	0	3	18	..	..	..
VI.	3 cwt. of common salt	1	4	0	20	3	1	2	
VII.	{ 2 cwt. of Peruvian guano and 2 cwt. of common salt }	1	8	0	8	7	0	18	
VIII.	2 cwt. of Peruvian guano	1	10	3	4	9	3	14	

A comparison of the preceding tabulated results suggests the following observations:—

1. Nitrate of soda, as in previous years, produced a considerable increase both in corn and in straw.

2. The larger application of nitrate of soda produced a correspondingly larger increase in corn.

It will be seen that whilst 1 cwt. of nitrate of soda and 2 cwt. of salt gave an increase of 9½ bushels of corn, 1½ cwt. of nitrate and 3 cwt. of salt gave an increase of 12½ bushels of corn, and 2 cwt. of nitrate and 4 cwt. of salt an increase of 15½ bushels. Thus for each ½ cwt. more nitrate of soda an additional increase of almost exactly 3 bushels of wheat was obtained.

3. In the third experiment 2 cwt. of nitrate of soda and 4 cwt. of salt gave scarcely a larger increase than in the fourth experiment, in which 2 cwt. of nitrate of soda was used alone. This was also the case in my wheat experiments in 1861; whilst in the preceding years of 1860 and 1859 the addition of salt to the nitrate of soda had a marked beneficial effect upon the wheat crop.

4. Salt alone, applied at the rate of 3 cwt. per acre, it will be seen, produced as large an increase as 1 cwt. of nitrate and 2 cwt. of salt.

This is a curious result, but it stands not solitary, for in 1861 salt alone produced an increase of nearly 7 bushels of corn. But as salt alone in the years preceding 1860 had hardly any effect upon the increased production of corn, it appears very desirable that further experiments with this cheap fertilizer should be made.

5. Peruvian guano, applied at the rate of 2 cwt. per acre, produced nearly as good a result as 2 cwt. of nitrate of soda.

6. The addition of salt to the guano, it appears, had little effect in further increasing the produce in corn, as it had in conjunction with nitrate of soda.

This is the more remarkable, since salt alone had such a favourable effect when used by itself.

7. Salt, added both to guano and to nitrate of soda appears to have checked over-luxuriance in the straw. Thus it will be seen that whilst 2 cwt. of nitrate of soda produced an increase of nearly $12\frac{1}{2}$ cwt. of straw, the same quantity of nitrate mixed with 4 cwt. of salt gave only an increase of $9\frac{1}{2}$ cwt. of straw in round numbers. And again, whilst 2 cwt. of Peruvian guano gave $9\frac{1}{2}$ cwt. of increase in straw, the same quantity of guano mixed with 2 cwt. of salt produced only an increase of 7 cwt. of straw. To show the commercial results I have constructed the following table, p. 108. The wheat is valued at 48s. a quarter, the price at which it was actually sold, and the straw at 30s. per ton, as a usual selling price.

As regards economy, there can thus remain no doubt that nitrate of soda, as well as Peruvian guano, either alone or mixed with salt, may be used with great benefit as top-dressings for wheat,—at least, on calcareous soils which, like our soils, contain an abundance of mineral plant-food.

On light land, guano and salt appear to me preferable to nitrate of soda or salt, because guano supplies phosphates and alkalies, as well as nitrogenized matters, whilst nitrate of soda is efficacious as a manure solely in virtue of its nitrogen.

Caution ought, therefore, to be used in applying this salt as a top-dressing for wheat on light land. The opinion that nitro-
genous

108 *Experiments with different Top-Dressings upon Wheat.*

TABLE showing the Money Value of the Increase in Corn and Straw per Acre over the Unmanured Plot in Experimental Field, and the Clear Profit after deducting the price paid for Manures.

Plot.		Money Increase in		Cost of Top-dressings.	Clear Profit.
		Corn.	Straw.		
		£. s. d.	£. s. d.	£. s. d.	£. s. d.
I.	{ 1 cwt. of nitrate of soda and 2 cwt. of salt .. }	2 18 6	0 9 4	0 17 0	2 10 10
II.	{ 1½ cwt. of nitrate of soda and 3 cwt. of common salt }	3 15 0	0 12 2	1 5 6	3 1 8
III.	{ 2 cwt. of nitrate of soda and 4 cwt. of salt .. }	4 14 6	0 14 7	1 14 0	3 15 1
IV.	2 cwt. of nitrate of soda ..	4 13 0	0 18 9	1 10 0	4 1 9
V.	Unmanured .. ..	.. ..	.. ..	.. ..	.. ..
VI.	3 cwt. of common salt ..	2 18 6	0 4 10	0 3 0	3 0 4
VII.	{ 2 cwt. of Peruvian guano and 2 cwt. of common salt }	4 7 0	0 10 9	1 8 0	3 9 9
VIII.	2 cwt. of Peruvian guano	4 4 0	0 14 10	1 6 0	3 12 10

genous top-dressings are beneficially applied to wheat grown on poor land requires to be accepted with discrimination. If the poverty, or rather unproductiveness, is caused by a bad mechanical condition and improper aëration of the soil, such top-dressings frequently produce marvellously beneficial results,—results, however, which perhaps are not greater than those attending deep-ploughing, exposure to air, and similar means for improving naturally unproductive clay soils. But if land is unproductive, like many sandy soils, simply because it does not contain in sufficient quantity all the mineral constituents which enter into the composition of the ash of wheat, top-dressings with nitrate of soda will tend to its more rapid exhaustion; and though such a dressing may for a season produce a somewhat larger corn-crop, it is doubtful whether the injury done to the land is not greater than the temporary benefit which is realized by the crop.

On the whole, I am inclined not to recommend nitrate of soda, as is commonly done, as a top-dressing for wheat on poor land, if, as explained, the poverty of the land is caused by a deficiency of mineral food; but I would feel little hesitation about using it liberally on clay soils and all land which good cultivation renders productive. Chemically speaking, the better the land—that is, the more abundant in it the stores of mineral food—the more largely nitrogenous top-dressings may be used, and *vice versâ*.

In concluding this report I have again to express my obligations

to Mr. Coleman, Professor of Agriculture in the Royal Agricultural College, for his valuable services in carrying out the preceding experiments.

Royal Agricultural College, Cirencester, Jan. 1863.

Further Experiments by Mr. STRATTON and Mr. FRERE.

Mr. Stratton, of Wallscourt, near Bristol, in the following letter addressed to Professor Voelcker, shows what very remarkable results may be obtained by the application of nitrate to an inferior clay soil, which, however, is not poor in a chemical sense, but full of mineral riches, of which the plant cannot without such aid, readily avail itself:—

“DEAR SIR,

“Wallscourt, 19th December, 1862.

“I take this opportunity of fulfilling my promise to send you the result of a trial made here of nitrate of soda on wheat.

“The soil on which the experiment was tried is an inferior and rather a poor clay, about the worst spot on the farm. The previous crop (vetches and winter oats) had been cut and carried off. The plant of wheat was good, but it looked weakly in March. I therefore sowed in April nitrate of soda at the rate of $1\frac{1}{2}$ cwt. per acre over the whole piece (3 acres), with the exception of one land in the middle. At harvest the unmanured portion was accurately measured, as was the adjoining land; and the produce was carefully kept separate and thrashed. The result was, without nitrate, 16 bushels per acre; with the dressing, 36 bushels 1 peck. The straw was quite doubled in quantity.

“Believe me, dear Sir, yours very truly,

“RICHARD STRATTON.

“To Dr. Voelcker.”

Mr. Frere's Statement.

I also was induced to use nitrate of soda in 1862 as a top-dressing for some wheat sown rather late on a clayey loam, better adapted to mangold than turnips. The field had grown barley and clover since a three-year-old saintfoin layer had been broken up and sown to mustard with 3 cwt. of guano per acre. The clover, a moderate crop, had been mown once, and afterwards furnished but a light folding. The plant being weak and backward, on the 31st of March one end of the field was dressed with nitrate and salt at the rate of $1\frac{1}{2}$ cwt. of nitrate and 3 cwt. of salt per acre; the other end had 1 cwt. of nitrate and 3 cwt. of

salt: one land in the middle had no top-dressing. The nitrate soon gave a beneficial impulse to the vegetation; but the cold wet weather in July, and the appearance of the crop at harvest, made me by no means sanguine as to the result. The three adjacent lands in the middle were harvested separately, and thrashed immediately after harvest, with the following results:—

Lands.	Quantity of Nitrate per Acre.	Cost of Nitrate.	Yield of Corn per Acre.	Value of Crop at 52s. per Quarter.	Increase in Value.
	Cwt.	£. s. d.	Bush. pks.	£. s. d.	£. s. d.
1	1½	1 4 0	32 2	10 11 6	1 6 3
2	..	..	28 2½	9 5 3	..
3	1	0 16 0	34 0	11 1 0	1 15 9

The early sale enabled me to make 52s. per quarter of the wheat, though all was about equally light, weighing about 17 stone per sack. Had the season been more propitious, I have no doubt that the result would have been still more in favour of the nitrate.

The quality of the land *slightly* improves towards that end of the field to which the smaller dressing was applied, but not to an extent that in itself can account for the difference in favour of the smaller dressing. The season probably turned the scale, though my manager considers 1 cwt. per acre enough to apply under similar circumstances.

The general and indiscriminate use of nitrate of soda to force the wheat crop is by no means to be advocated. I fully concur in Professor Voelcker's opinion, that it is chiefly serviceable on soils which, if not heavy, at least have a good staple; even there, if the plant is already forward and vigorous, its use may do more harm than good. The success with which it has been applied generally to the wheat crop on the light lands of Holkam and other parts of Norfolk, turns, perhaps, upon the fact that the occupiers of those soils generally have access to a marl pit—a mine of wealth which other light-land farmers envy them. Where you can marl, you may use nitrate of soda freely; and conversely, perhaps, where nitrate is in common use, the fear of an over-dressing of marl is much diminished.

P. H. FRERE.

VII.—*Earth versus Water for the Removal and Utilisation of Excrementitious Matter.* By the Rev. HENRY MOULE, Vicar of Fordington, Dorset.

SUMMARY OF CONTENTS.—I. Principles of the Earth-system. — II. Facts and Testimonies as to its Efficiency. — III. The Value of the Manure produced. — IV. Application of the System to Cottages and Public Institutions. — V. The present condition of our Towns. — VI. The pressure of costly Improvements on the Working Classes. — VII. The application of the System, and supply of Earth to Towns. — VIII. Companies to carry out the System.

My proposal to employ earth instead of water in one branch of domestic economy was first made in a pamphlet, published in 1858, entitled 'National Health and Wealth.' The force of the facts and arguments then adduced has been very generally felt and admitted by scientific and 'practical men; yet the force of habit, the objection to radical change, and a natural disinclination to discuss the details of a subject which is in some respects offensive, together, perhaps, with the want, only recently supplied, of a simple, certain, and effective apparatus, have hitherto prevented any large or general adoption of the system proposed. Every month's experience, however, proves it capable of promoting, not only the health and wealth, but (what is of equal value in another point of view) the general comfort of the nation.

Our fields and gardens urgently demand a larger and cheaper supply of manure than that which now exists, which, moreover, is insecure and may be much diminished within a few years: and, on the other hand, loud complaints are uttered of the worse than waste of the sewerage of our towns, villages, and private dwellings. It may, therefore, be of some service, especially to the agricultural interest, if I give a brief statement of the principles on which the system of earth sewage rests, some facts and testimonies explaining and recommending the suggested mode of working it, and facts and evidence illustrative of the value of the manure manufactured after the plan proposed: for, thus, I think that it may now most satisfactorily be proved that the increased demand for fertilising agents may be largely met; the health of towns promoted by the entire removal of the sewage nuisance, instead of the present mere palliation; and the pollution of our streams and rivers prevented, the evil being no longer shifted from one quarter to another. Moreover, all this good may be secured without any of those vast and extravagant works for public drainage which add so greatly to the burdens of the country. In one county-town, at least, the public works

have added 6*d.* a-week to the rent of the cottage of the mechanic and labourer; while the earth system, fully and fairly carried out, would have increased his income. At all events there is a great national evil to be dealt with which urgently demands remedial measures.

This remedy is not restricted to towns, but is equally applicable to that great portion of our population which is scattered abroad in villages and detached houses, under circumstances which call for special consideration, since such districts often exhibit a higher rate of mortality than that of the metropolis and other first-rate towns which have hitherto almost exclusively occupied the attention of sanitary reformers.

I. Principles of the Earth-system.

I.—The first fact or principle on which this system is based—viz. the power of dry and sifted earth, especially if it partakes of the nature of clay, to absorb and retain ammonia and other fertilisers,—was first pointed out by Professor Way in his two papers, printed in this Journal, on ‘The Power of Soils to absorb Manure,’ in which reference was made to the observations of the Rev. A. Huxtable and Mr. H. S. Thompson. The object of those papers, however, differed considerably from that now entertained. Then the power of the earth to retain gaseous soluble fertilisers was the point chiefly dwelt upon; now, attention is specially directed to its efficient action in the removal of the effluvia from our animal and vegetable refuse.

It was to this point, but particularly to the *repeated action* and consequently the repeated use of the same earth, that I first directed the attention of the public. I then pointed out—1st. that a very small portion of dry and sifted earth ($1\frac{1}{2}$ pint) is sufficient, by covering the deposit, to arrest effluvia, to prevent fermentation (which so soon sets in wherever water is used), and the consequent generation and emission of noxious gases. 2ndly. That if within a few hours, or even a few days, the mass which would be formed by the repeated layers of deposit be intimately mixed by a coarse rake or spade, or by a mixer made for the purpose, then in five or ten minutes neither to the eye nor sense of smell is anything perceptible but so much earth.

My first attempts to carry out this principle were extremely rude. After closing up the vault or cesspool on my premises, I employed movable buckets, which were emptied from time to time and mixed with garden earth. Even this mode of removal, though offensive in idea, in great measure remedied pre-existing evils. The removal and mixing only occupied a boy's time for a quarter of an hour; and after all was com-

pleted, within ten minutes, neither eye nor nose could perceive anything offensive.

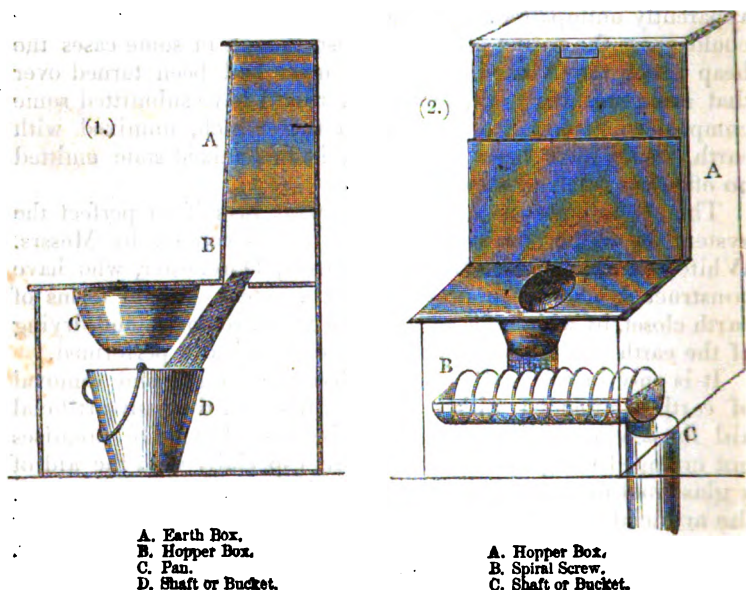
When about three cart-loads of sifted earth had been thus used for my family, which averaged 15 persons, and left under a shed, I found that the material first employed was sufficiently dried to be used again. This process of alternate mixing and drying was renewed five times, the earth still retaining its absorbent powers apparently unimpaired. Of the visitors taken to the spot none could guess the nature of the compost, though in some cases the heap which they visited in the afternoon had been turned over that same morning; and more than this, I have submitted some compost to strong fire heat, when that which, unmixed with earth, would have been intolerable, in this mixed state emitted no offensive smell whatever.

This experience induced me to exert myself to perfect the system, in which endeavour I have been seconded by Messrs. White and Co., of 45, High East Street, Dorchester, who have constructed, under the protection of a patent, several forms of earth closet, by which the supply, admixture, removal, and drying of the earth can be satisfactorily and economically performed.

It is only in towns where the delivery, stowage, and removal of earth is attended with cost and difficulty, that any artificial aid for drying the compost would be desirable. On premises not cramped for space the atmosphere, especially with the aid of a glass roof to the shed, will act sufficiently fast. At all events, the artificial heat required may readily be applied to a chamber from any existing flue; the recently patented *vapour-fed stove*, or *cottage range*, by proper arrangement of its flue, would dry enough for several hundred people with about two pennyworth of fuel daily. It might be feared that in the drying much of the ammonia would be lost; this, however, would hardly be the case, unless the heat employed exceeded 212° ; indeed, the manurial effects produced by this compost lead me to doubt whether there can be any loss.

The apparatus to be used would of course vary with the position of the householder. For a cottager, the present vault in the cottage-garden should be filled up, and a square enclosure of brick or stone made under the seat, of the same dimensions as the seat itself. The bottom, which should be water-tight, is placed three or four inches below the level of the floor of the place. At the back of this inclosure there should be an opening, with a door resting on not more than six inches of solid work above the floor, for the removal of the earth when necessary. At the back should be a rough shed, capable of containing a cartload of earth, divided into two compartments, one on either side of the door; the earth when used may be shifted backwards

and for wards from side to side, each compartment being alternately the wet and dry store. Thus used, one load of earth will be sufficient for two or three persons for six, if not for twelve months. This is the simplest mode of application. For better houses and larger establishments, closets in one of the two forms given below may be employed.



In both closets a box is placed above and behind the seat, which contains the dried earth, and delivers it through a hopper.

In closet No. 1, the pan C has a moveable bottom, which, by lifting a handle or *by self-action*, is made to turn upwards in a curve outside the back of the closet. When this bottom falls back into its place, the hopper delivers the earth outside and beneath the pan, so as to prevent any escape of dust.

The self-acting seat is an important feature in closets designed for the use of schools, hospitals, asylums, &c.

In closet No. 2 a spiral screw, placed in a semicircular trough, is worked by a handle and pinion, which also acts on the hopper in the earth-box. As the handle moves, the "soil" sinks with the revolution of the screw, and the hopper at the same time delivers earth to cover it. In passing through the spiral, paper is torn to pieces, and a thorough mixture effected. A four or six inch down pipe may be placed under the end of this screw.*

* I have, for my own satisfaction, procured the above illustrations from Messrs.

With regard to the earth to be used, I have found ordinary garden surface soil quite effectual; and a subsoil containing a large proportion of clay or silicates of alumina and potash, would furnish a good material; but if clay soil be scarce, an admixture of coal-ashes or street sweepings would not be objectionable. But nowhere could there be any difficulty in procuring such a supply as should, by repeated use, be converted into a highly valuable compost. For consider how towns are supplied with straw by farmers who undertake all the cartage without payment for the sake of the manure. If the three or four loads of manure returned for every ton of straw delivered, is an adequate compensation, such a compost as would be effected by five or seven-fold use would (as we shall see from actual experiments) be highly remunerative, and the farmer can more readily furnish this earth, which is to be returned to him, than the straw.

II. Facts and Testimonies as to the Efficiency of the System.

II.—Let me instance cases where this system has been applied to the satisfaction of those concerned.

Mr. Young, a mason, residing near Dorchester, has for two years had an earth-closet in a small room within ten feet of that used by his lodgers, the curate's family, as a dining-room. He has removed the earth only once a week, but never has any offensive smell been perceived in his house.

Major Nugent, R.E., under instructions from the War Office, tried the system at Portland; and whatever may have been the judgment of the authorities at the War Office, from the statement made by that officer to myself after four or five months' experiment, I cannot doubt that the tenor of his report was favourable. Before making it, he invited me to judge on the spot how far I was satisfied with the experiments, which had fully satisfied himself. I went to Portland, and inspected the two closets which had been used by sixteen convicts, and found the place in which these stood was free from offence. In company with another engineer officer, and the clerk of the works, I next visited a pug-mill, the use of which I had recommended for mixing the contents of the boxes. Two men brought thither a box containing the deposit of two days. This was emptied on the floor, without causing any offensive smell; but as it passed through the mill a slight effluvia was perceptible. Within ten minutes, however, the mass became simply dark, inoffensive earth. And we agreed that if there

White, and learnt from them that the price of No. 1, with lifting handle, is 2*l.* 7*s.* 6*d.*; with self-action, 2*l.* 15*s.*; the machinery alone, if sent to be fixed to a common closet, costs 1*l.* 5*s.* The price of No. 2 is 4*l.* 10*s.*—P. H. F.

should ever be 3000 men in the fortifications of Portland, and this system should be adopted there, provision might be made for the whole garrison without any offensive smell or escape of noxious gas arising, whilst every day there might be manufactured three tons of valuable manure. What, then, would be the result if these means were applied to the camp at Aldershot and to the barracks of the United Kingdom? The cost of the two closets here used could not have been more than 50*s.*, besides a rough pug-mill; the labour required was that of two men for twenty minutes every other day; the earth was dried by the atmosphere.

The Vice-Chairman of the Board of Guardians at Bradford-on-Avon, writes to me that from the same earth having been dried and used repeatedly at the school of the union-house, in which there are 55 children, the whole compost did not exceed a cart-load and a half, or 30 cwt., at the end of five months. And with respect to health, comfort, and cleanliness, this gentleman tells me that where, previously to the use of earth, all had been "noxious pungency," there is now nothing whatever that is offensive. He adds that the earth was dried by the atmosphere "under a few pantiles;" the labour required being that of an old pauper for about half an hour a day.

III. *The Value of the Manure Produced.*

In the present stage of the working of this system, the difficulty of ascertaining the value of the manure thus manufactured is very great. The variations in the earth used, and the want of exactness in observing the relative weights and proportions of the "soil," and of the absorbing earth, as well as in obtaining a thorough mixing of the two, combine to create this difficulty; I therefore prefer to give a few instances of the practical application of it to the garden and the field, rather than to attempt to offer a scientific analysis of its composition. In planting cabbages I have taken a handful or two of that which has passed through the closets five times, and, putting it into the watering-pot, have used it in a liquid form, filling the holes in which the plant is to be set; and I have found that if this liquid manure be made too strong, it burns the root of the plant, even as guano would. A new gardener, not believing that there was much virtue in the heap of inoffensive earth he found lying in the shed, thought if there was anything in it, his celery plants should have enough of it. He threw over them little more than a handful, and this burnt them up. With 6 lbs. weight I planted in a piece of unmanured ground 40 dozen brocoli and savoy plants. No plants could be finer than they were. A cottager at Bradford Abbas commenced the system in his large cottage garden in the

spring of 1862. He applied the manure to patches of man-gold and swedes; and the land steward who persuaded him to try it, states that he never saw such fine roots as were then grown.

In 1860 a farm bailiff received from me one cwt. of mixed earth from my stock of three cartloads, which had passed five times through a closet used by fifteen persons, and had subsequently lain in the shed full seven months. He applied it to a quarter of an acre of ground, drilling it in with swedes. To the remainder of the field of four acres, an equal dressing of superphosphate was applied. The crop, though injured by the rapid growth of weeds in that wet trying season, was good. But the roots in the quarter of an acre, which received the mixed earth, when pulled up and weighed, exceeded by one-third any that could be found in the rest of the field. In 1861 this same field was sown to barley. Throughout the growth of the crop the appearance of this same quarter of an acre, with no additional manure, was manifestly superior to that of the remainder of the field; and the bailiff estimated the produce to be in the proportion of four to three.

Again, in the spring of 1862, Mr. R. Hayne, of Fordington, received from me 4 cwt. of earth which had passed seven times through the closet, and had afterwards lain for six months in the shed. This he used, at the rate of 1 cwt. to an acre, instead of crushed bones on a piece of very poor land to be sown to turnips. Both he and Mr. R. Damen, of Dorchester, a well-known agriculturist, consider the crop to have been remarkably good; and that crushed bones could not have answered better as a manure.

According to these experiments, then, whatever the marketable value of manure thus manufactured may prove, such compost used five times over is as effectual as superphosphate in promoting the growth of turnips, and therefore may be priced at the same rate per ton, whilst more repeated use might bring it up to the value of guano.

The value of this manure might also be estimated from the relation between the bulk of earth used and the number of persons availing themselves of the closet for a certain time. We have seen that three cartloads served fifteen persons for half a year, being used five times over in that time. At that rate 1 ton would last two and a half persons for a year. Now, if we reckon that the total excreta of a man have an average value of 1*l.* per annum (they have often been set much higher), we thus arrive at a value of 2*l.* 10*s.* for each ton of earth used five times, or of 3*l.* 10*s.* for that used seven times.

IV. Application of the System to Cottages and Public Institutions.

If these principles and plans be correct, their adoption may be quite experimental at its commencement; progressive in proportion to success, involving, therefore, no great risk; and, if successful, a source of wealth and comfort to the community. This is the only plan which can, with any degree of economy and comfort, be adopted *by all classes* in detached houses and villages. Such spots are, therefore, its most obvious sphere of action. Public institutions, such as unions, gaols, the dormitories of public schools, and the wards of hospitals—all afford facilities for its application, and for a thorough testing of its sanatory and economical results.

The economy of the system will not depend solely, or even chiefly, on the money-value of the manure manufactured, but in a great degree on dispensing with the large outlay which the water-system involves. I will instance the National schools in a borough town, which is under the water-system. There are 300 boys and girls attending those schools. It has cost 70*l.* to connect them with the sewers: it would not have cost 20*l.* to provide them with self-acting earth-closets. In a county gaol it costs 50*l.* a-year to keep in order the water-closets by which the manure of 150 prisoners is wasted. Apply the earth-system—the repairs of which would not be 5*l.* a-year—and thus nearly 200*l.* a-year will be saved to the country. In confirmation of this opinion, the intelligent master of the Kingswood Reformatory, who was sent to me by the Committee to inquire into the system, expressed his conviction that he should be able to make from 100 boys 200*l.* a-year, and at the same time prevent abominations in the way of offensiveness, that can scarcely be told.

If this earth-system, then, be thus conducive to health, comfort, cleanliness, and wealth, let us consider its application to particular cases. In general, in the detached, or village cottage, the only means for the removal of filth is a privy with a deep vault, either so near to the house as to be noxious and offensive, or so far from it as to be inconvenient, and so placed as to be generally indecent. The sink-water and slop-bucket are emptied either into a hollow near the door, where perhaps there is a small manufacture of manure, or into the neighbouring brook or ditch. There is no provision made for night, nor for upstairs accommodation; and the evils arising from this none can estimate but those who have visited largely amongst the labouring classes in time of sickness. Such are the sanitary arrangements—if they can bear that name—in one small parish in Dorset, in which, during the eight years ending December, 1861, the average of

deaths was 32½ in 1000. Now what improvements in such cases is the earth-system capable of introducing? In the first place, you may by means of it have a privy close to the house, and a closet upstairs, from neither of which shall proceed any offensive smell or any noxious gas. A projection from the back of the cottage 8 feet long and 6 feet wide would be amply sufficient for this purpose. The nearer 3 or 4 feet downstairs, would be occupied by the privy, in which, by the side of the seat, would be a receptacle for dry earth. The soil and earth would fall into the further 5 or 4 feet, which would form the covered and closed shed for mixing and drying. Upstairs the arrangement would be much the same, the deposit being made to fall clear of every wall. Through this closet the removal of noxious and offensive matters in time of sickness, and of slop-buckets, would be immediate and easy; and if the shed below be kept well supplied with earth, all effluvia would be almost immediately checked. As to the trouble which this will cause, a very little experience will convince the cottager that it is less, instead of greater than the women generally go through at present; whilst the value of the manure will afford an inducement to exertion.

V. The present condition of our Towns.

Finally we have to consider the position of our large towns, where a national evil is growing up which demands immediate and serious attention. Without enlarging on the revolting details set forth in recent Parliamentary Reports respecting the accumulation of filth connected with the "middens" of Manchester, let us consider, in the case of Birmingham, the great outlay and the perplexities which have arisen from partial and unsuccessful attempts to carry out the water-closet system, according to the evidence furnished to the Select Committee on the Sewage of Towns, by Mr. Till, the Borough Surveyor, and Mr. Standbridge, the Town Clerk.*

In that town, of 250,000 inhabitants, it appears that about 26,000*l.* have been already expended in the mere purchase of land, and the construction of two high-level sewers and two tanks; that this fraction of the work involves an annual expenditure of 1500*l.*; and that it is in contemplation to raise, under an Act of Parliament, 100,000*l.* for carrying out this system, which has involved the town in "endless troubles and litigations."

On the one hand the authorities are threatened with an action

* First Report, pages 65, &c., and 78, &c.

for turning the sewage *into* the river, on the ground that the solid matter held in suspension in the sewage has filled up a mill-course; on the other, legal proceedings are pending for diminishing the supply of water to a mill-stream, by taking sewage *out of the river*, although the water mixed with the sewage is in a great measure not a natural, but an artificial supply, derived from the town's waterworks, it being found impossible to distinguish natural from artificial supplies of water when they are mingled together. And yet again attempts to utilise the sewage are, to a considerable extent, thwarted by the gas-works, which, "slyly and secretly," pour into the river a great deal of matter which is injurious not only to vegetation, but to animal life; so that further actions against the town, for the destruction of fish in the Trent, are also expected.

We also learn that it is still quite an open question what new sanitary measures should here be adopted, because at present not more than one-twentieth part of the houses have water-closets. If the prospects held out by the water system are not promising, the older arrangements are as objectionable on the score of economy as of health. At present the cost of getting rid of the night-soil, the bulk of which is said to be enormous, comes to 6000*l.* a year; and about seven years ago (when Mr. Standbridge was appointed Town Clerk) it was 11,000*l.*

Even at Birmingham, where such strenuous efforts have been made on behalf of the water system, we find that a measure is in contemplation which turns upon the admixture of soil and earth, though after a rude fashion. It is proposed to lift by steam-power the solid matter deposited by the sewage in the tanks (which by itself, unless given away, is in but little request as a manure), and to mix it with night-soil. The night-soil is to be screened from the bulkier matters which are added to it in large towns, and the remaining cinders and "breezes" (as they are there called) are to be crushed to powder.

"It is," according to Mr. Standbridge's statement, "a remarkable fact that when that carbonaceous matter, either in the shape of cinder or coal, is crushed, the most filthy night-soil that you can conceive becomes without smell, comparatively speaking; so that the crushing process will be absolutely a means of preventing the accumulation of night-soil being a nuisance, and it will at the same time create a very valuable manure indeed. About the value of it there is not the least doubt."

Thus while the onward course of water sewage is beset with expense and difficulty, a rude modification of the earth system, using but inferior materials, has forced itself into notice.

VI. The Pressure of Costly Improvements on the Working Classes.

In carrying out the drainage system Boards of Health and their promoters have not sufficiently considered how heavily public works for sanitary improvements press upon the working classes, by increasing their rent.

The ordinary allowance for rent out of a man's income is 10 per cent., but in Dorchester many a working man has to pay 25 per cent., or 2*s.* 6*d.* out of 10*s.* a week; and to this a water- and drainage-rate may add 3*d.*, 6*d.*, or 9*d.* a week. And as wages do not increase in proportion, the necessity is thus originated or increased of taking in lodgers, generally without regard to character, in order to pay the rent. The impure air of crowded rooms becomes thus another, or an increased source of physical evil; and the moral evil occasioned by the larger crowding of persons into sleeping-rooms, without distinction of sex, age, or character, is far greater than that, the remedy of which is sought in the drainage system.

VII. Application of the System and Supply of Earth for large Towns.

On these two points the public has hitherto appeared especially sceptical; nor, considering the novelty of the proposed system, is this unbelief to be wondered at. The late Henry Austin stated to me, that until he actually saw the simplicity of the mode of application, and the small quantity of earth necessary for each use of the closet, he could not believe in the applicability of earth to this purpose. "But now," he said, "I see that you have solved our great question." And so satisfied was he of this, that he obtained from me a statement for which he wished and endeavoured to obtain insertion in the second Report of the Sewage Commission. The truth is, that the machinery is more simple, much less expensive, and far less liable to injury than that of the water-closet. The supply of earth to the house is as easy as that of coals. To the closet it may be supplied more easily than water is supplied by a forcing-pump; and to the commode it can be conveyed just as coal is carried to the chamber. After use it can be removed in either case by the bucket or box placed under the seat, or from the fixed reservoir, with less offence than that of the ordinary slop-bucket—indeed (I speak after four years' experience), with as little offence as is found in the removal of coal-ashes. So that, while servants, like others, will shrink from novelty, and at first imagine dif-

facilities, yet many, to my knowledge, would now vastly prefer the daily removal of the bucket or the soil to either the daily working of a forcing-pump or to being called upon once a-year, or once in three years, to assist in emptying a vault or cesspool. If a mixer, with its horizontal pug-mill, be placed at the bottom of the shaft from below a fixed closet, or if it be used instead of the spade or rake for mixing, the offence to the remover is literally nothing.

But how for a town of any size would you obtain a sufficient supply of earth or clay? In reply to this reasonable inquiry, it may be remarked, that even if a town happen to have no available supply of clay in its neighbourhood, the street sweepings may, with a little care and management, be made available for the purpose; and coal-ashes (though not a good substitute for clay when used alone) may be combined with these and with some surface-soil. About a supply of surface-soil there can be no real difficulty, since, after having been enriched, it is to be returned to the garden or field from which it was taken. Would there be anything novel in such a process? Is it not, in fact, more simple and less expensive than the common practice of supplying straw to stables for the sake of the manure there produced? In that case the amount of carting required is large; for 1 ton of straw makes three or four loads of manure, all of which has to be carted home; whereas the ton of earth, after being removed five times no further than to an adjacent drying-ground, is converted into a ton of compost, more valuable than all the manure made by the ton of straw.

If we look to special instances, it would be easy to point out many more towns which cannot find a good outfall for liquid sewage or an area suited to irrigation, than neighbourhoods devoid of clay earth. Weymouth is a case in point, where any system of water-drainage would, from the position of the town and the consequent expense, be almost impracticable, whilst dried mud from the Back-water, or clay from the neighbouring hills, would form the basis of a most valuable manure for the adjacent heaths.

To complete these arrangements, instead of the soil-water used in the kitchen being thrown into a hole at the door, or into the ditch, a small hollow should be made and filled up with a barrow-load or two of earth, which, if it be removed and dried when saturated with such water, will afford a further supply of valuable compost.

In like manner the earth-system may be advantageously applied to urinals either in railway-stations and barracks, or in crowded thoroughfares.

VIII. *Companies to carry out Earth-system.*

If then we contrast the prospects of the earth-system as applicable to towns, with its struggling, halting rival, the water-system, it appears that in the first place no expense for public works, such as main and branch sewers and drains, is required. Secondly, when the merits of the system have been tested and established in our public establishments, such as unions, &c., companies will be formed which will take upon themselves the working expenses, and find *at least* a sufficient profit in the value of the compost. If this when used five times obtains a value of 2*l.* 10*s.* per ton, the poor may look for some payment for the soil, and the servants of the richer classes for some gratuities, since a much less value than this would pay for supplying, removing, and drying the earth. The only expense, then, that would fall upon the town, the owner, or the tenant, would be the fitting up of the closets, which in general need not be one-fourth of that of a water-closet.

The actual profits of such a company would of course vary with each particular district, according to the facilities with which clay could be procured, and the proximity of heaths or light lands, for which the compost would have a special value. The strength given to the manure would also vary according to circumstances; but without doubt, by the repeated use of the same earth, or by sifting the products of the closets before mixing them, its virtues may be so condensed as to render it equal to guano or any artificial manure. Thus prepared I have found it also to be equally deodorised. In this state, therefore, it is as capable of transmission to any part of the country as guano or superphosphate, being entirely free from the offensive smell of either. In this power of transmission it stands in striking contrast to liquid sewage.

In conclusion, I would remark, that let one-fifth of the population of Great Britain adopt and thoroughly carry out this system, and one million tons of manure, equal to guano, will every year be added to our supply of fertilisers. Let it be adopted in our towns on the sea-coast, and in our large centres of manufacture, such as Birmingham or Bradford, and its benefits may rapidly be conveyed to many a hill now barren, and may change many an unprofitable heath into fruitful fields. Let our landowners introduce it, with one or two other improvements, into their cottages, and the comfort, contentment, and prosperity of the working classes will be much promoted.

VIII.—*The Money-value of Night-Soil and of other Manures.*

By P. H. FRERE.

WHATEVER be the issue of the struggle between earth and water (as indicated in the preceding paper) for taking under their protection that which is called "night-soil," it is essential that the value of the substances with which they propose to deal should be well investigated and established; yet on this question ardent reformers and scientific chemists are at the present moment much at variance. The former, basing their calculations on the *cost* of man's food and remarking the very high value assigned to the manurial virtues of some principal cattle-foods, produce estimates which, although apparently framed with great moderation and due allowance, may be still wide of the mark because they are built on an unsound hypothesis.

In truth, the cost of an article as food is hardly any criterion of its value as manure. Indeed, since the refuse of a product is often in this respect more valuable than the extract, it might almost as well be asserted that the cheaper article had the higher manurial value; the relation of wheat-flour to bran and of oil to oilcakes being cases in point, of which the former is material to the question before us; since if the value of man's excreta were calculated on the supposed number of bushels of *wheat* required for the supply of the population, the sum arrived at would be too high, because that part of the wheat which has the highest manurial value, viz. the bran, would practically not be consumed by him. If, again, we look to meat, the other important element of his diet, it at once appears how little the price of food has to do with its manurial value.

In reply to an inquiry, Dr. Voelcker has obligingly furnished me with the following information as to the probable manurial value of a ton of cooked meat which has served as food for man:—

"Cooked meat contains, in round numbers,—

Fibrin	..	..	..	..	..	..	18 per cent.
Fat and mineral matter	..	..	..	..	..	..	4 "
Water	..	..	..	..	..	..	78 "
							100 "

"Fibrin contains 16 per cent. of nitrogen; and consequently 1 ton of meat yields in round numbers about 30 lbs. of ammonia, worth 15s. If the meat is all consumed by full-grown men, and consumed with starchy food, most of the nitrogen is again found in the excreta. Supposing about $\frac{1}{2}$ ton to pass off in the exhalations (I am afraid to give you positive data, for the determinations of different experiments vary considerably), then the ton of meat made into manure would be worth about 12s."

At this rate, the manurial value of cooked meat is about 1-15th of a penny per lb., or 1-100th of its cost, if it be valued at about 6½d. per lb.,—a low price for cooked meat.

But if these great staples of human food fail the “bulls” of the sewage question, what shall we say for the odd pennyworths of vegetables, &c., bought at a town-market or from the green-grocer, when the price paid is quite fictitious! The probability, therefore, is very great that such calculations based on the cost of man’s food will be wide of the mark; and that this is the case when a yearly value of 3*l.* to 4*l.* per head is arrived at, is pretty certain. Even the more moderate estimate of 1*l.* per head is contrary to the opinion of our best agricultural chemists, who seem thoroughly agreed in fixing on a much lower value, viz. that of 6*s.* per head, supposing all the constituents contained both in the liquid and solid excreta to be preserved without any waste, that valuation being made at the customary rates employed in connexion with analyses of guano. Both Mr. Lawes and Dr. Voelcker have favoured me with independent but concurring information on this point; whilst Professor Way, when questioned on the subject by the Sewage Committee, referred to Mr. Lawes’ calculations with approval; the teaching of Professor Anderson also, so far as I have become acquainted with it, decidedly takes the same direction.

Our leading scientific authorities, then, are agreed on this point; and why should we gainsay their conclusions; and what more trustworthy evidence have we to build upon? Would they not all have felt much more satisfaction in giving a reply more favourable to the march of improvements which Science regards as in some degree her own bantlings? Shall we listen for a moment to an insinuation that interested motives have actuated them in consequence of their connexion, more or less direct, with the market for imported manures which might suffer from new competition?

Surely such opinions, based on careful scientific investigations, must prevail, at least until they are encountered by conclusions drawn from a greater amount of accurate and repeated experiments than we are yet furnished with.

As to the bulk of these excreta, there can be no doubt.

According to Liebig, the annual fluid and solid excrement of a million inhabitants of large cities (men, women, and children) weigh in the dry pulverulent state 45,000,000 lbs., in which are contained 10,300,000 lbs. of mineral substances, mostly ash constituents of bread and meat. “These human excrements alone contain 4,580,000 lbs. of phosphates.” *

* See Liebig’s ‘*Letters on Modern Agriculture*,’ 1859, admirably rendered into English by Dr. Blythe, of Queen’s College, Cork.

With this estimate of 45 lbs. per head yearly Mr. Lawes agrees; and Professor Way gave substantially the same answer when in round numbers he stated to the Committee on Sewage of Towns the amount at 1000 grains per head per day, equal to 1 lb. per week. Liebig's estimate for the phosphates, of about 4½ lbs. per head, valued at 3d. per lb., would only give a money value of 14d. for that important item. He does not mention nitrogen in this passage; neither can I tell the comparative value as between this substance and phosphate which would meet with his sanction and approval; but he can hardly make a greater, if so great, a distinction between the two as our English chemists.

The proportion existing between the phosphates and ammonia in excreta, as found in sewage, is, I believe, considered pretty constant; so that if the amount of nitrogen is *determined*, that of the other element may be safely estimated, the ammonia being double the phosphates, according to Dr. Hofman's calculations.*

So, then, as to bulk and relative proportions the authorities of different schools appear to agree, and the question of price or valuation only remains.

On this point, speaking as a practical farmer, I am disposed to complain that all our chemists put on the constituents of manure a value in some cases too high, in others almost imaginary. In truth, the question of value does not belong to science but to commerce; and all the advice which a scientific man, as such, can offer will be on the *comparative* value of different sources of the same fertilizer.

To the eye of Science all elements of plant-food have an equal importance—are equally essential; their value only varies according to the difficulty experienced in securing a supply, and of this difficulty Commerce is the sole arbiter, the purchaser limiting the course of trade by refraining from an unremunerative purchase. Yet from questions of value the philosopher cannot stand quite aloof; and therefore from time to time, startled, it may be, by local abuses, he sounds an alarm, in which his want of familiarity with the marts is as striking as his scientific knowledge is admitted. But the practical man, not much moved by general accusations of wasting plant-food or the mineral constituents of plants, will review his requirements in detail, when the list will appear to be neither very long nor very formidable.

On the nitrogen he will have kept a pretty sharp look-out, as an element of which the waste is considerable and the difficulty of supply great. In regard to phosphate, he will probably have been for some years a greater buyer than seller, and he will thank

* See 'First Report of the Select Committee on Sewage,' p. 26.

God's providence for the mineral stores now disclosed in England and France, and no doubt hidden elsewhere. Of the alkalies, he will husband his store by not selling straw, if his land be light and the subsoil do not contain stores of wealth in reserve. For carbon he may in the long run rely on the atmosphere, which supplies carbonic acid freely enough, however scanty may be its *available* supplies of nitrogen. As to lime, if any difficulty exist, it is one he can easily measure, and probably remedy at no great cost. In this instance a natural defect in the soil, not any conceivable waste of man, will generally be the obstacle to be overcome. Silica and silicates will puzzle him, perhaps, but not him only; and he will wait till a special indictment is laid against him for wasting substances which do not appear to impart much value to granitic detritus, whether it be in the offscouring of our granite-paved streets, or the deposits borne by streams from primæval mountains. And at this point he will have about exhausted the list of elements, which, spoken of *in the abstract*, sounds such a formidable bugbear!

If, however, the scientific man be consulted on a question of value, his natural course will then be to refer and gauge each new import or product by an old standard, according to the rates which trade and commerce indicate.

But if it be true that what is new and of partial application should be gauged by that which is established and familiar to all, it seems startling that authorities should assume, or even recognise, Peruvian guano as the standard of the value of manure for the purpose of comparison. Can this be historically correct? Is it sound in a commercial point of view? Men of middle age who have watched the rise and progress of the entire market for artificial manures, will recollect that, when guano first appeared, bones and soot were almost the only auxiliaries of farmyard-manure in common use. The farmer had a good notion of the value of the latter, but it was a composite body, so the market price of bones (in which phosphate predominated) and that of soot (chiefly valued for its ammonia) were of assistance in the difficult task of assessing the various elements in the straw-manure at their widely different money-values. The star of nitrogen was then in the ascendant, and accordingly the chief place was assigned to it—a pre-eminence not yet reversed, in spite of the overriding of mineral and atmospheric theories since that time. The Prices Current appear, *on the whole*, to justify that award, being as dispassionate critics of chemical philosophy as the Funds are of statesmanship.

If at that time a chemist had told a farmer, "Guano is worth 20 and 20, and therefore good farmyard-manure must be priced at 12*s.* or 13*s.* per ton," would he not have been told with a smile,

"Let me alone to know how much I can make of a ton of straw manure, and tell me what you think this new fancy article is worth, supposing I can make (say) 8s. per ton of the old stuff when it lies handy for use."

But, whether this view of the course of events be correct or not, it surely never can be right or expedient to regulate our prices by that of a material which is the subject of a monopoly, and can therefore be raised or lowered by an arbitrary fiat at any moment; nor is it at all necessary to do so when equivalent supplies can be obtained from so many other quarters by various agencies.

My first objection to the standard adopted is, that it is generally too high.

To establish this point, I shall first cite as a witness Dr. Voelcker, who, in his *Lecture on Sewage* (see vol. xxiii. page 466), has told us that the *calculated* value of a ton of rotten dung is 13s. 6d., or of fresh dung 13s.; "at the same time that 3s., or, at the most, 5s. per ton, is the price generally given for farmyard manure." To account for this discrepancy, the chemist can only allege the cost of carting the more bulky substance; but straw manure is generally disposed of within such a range that each cart carries at least two loads per day, and a leisure season or a wet day is selected for doing the work, so that 2s. or 3s. per ton is generally the utmost cost of delivery. When delivered on the field, this manure supplies fertilizers in the very best shape for plants; neither too dilute nor too concentrated, too slow nor too quick in operation. For stiff soils the bulky straw is mechanically of use; for light sands, where some artificials are too stimulating, its power of retaining moisture, and the supply it affords of alkalis, are specially serviceable; so that when delivered, its *form* is unimpeachable, and it cannot on that account be subjected to an abatement. By what plea, then, can this great divarication between theory and practice be justified?

My own estimate of the worth of farmyard-manure has practically been reduced into the following shape:—

Being able to procure good London manure at a neighbouring railroad-station for 8s. 6d. per ton, I gladly avail myself of this supply when there is a prospect of wheat making 7s. per bushel, and when my field is almost as accessible from the station as from the homestead, but otherwise I am indifferent about it.*

* This view may be roughly verified, as follows:—Say that the addition of 12 tons of manure to a field raises the crop from 16 to 32 bushels per acre, the manure at 8s. 6d. per ton will cost a little over 5l., i.e., the value of 2 quarters of wheat at 50s. The increase of straw will pay for extra labour in harvesting and marketing; and the virtue still left in the field for the succeeding crop must be looked to for a profit.

On the other hand, my advice to a friend who can get London manure delivered at a wharf abutting on his farm at about 5s. per ton is, "Never mind stock-farming, except for choice specimens; sell your straw, and buy manure." This view tallies very well with Dr. Voelcker's statements of common practice; but it cannot be reconciled with a valuation which assigns 13s. as the price of a ton of dung delivered. Is there not some ground to ask for its revision?

If, however, this scale of valuation is unsound, has it not been practically mischievous? If a good sample of genuine Peruvian guano, or a good superphosphate, was analysed and valued *at this rate*, the Report, until lately, often assigned to it a value considerably above the market price. Is it to be wondered, then, that the Peruvian Government was tempted to raise the price to the estimate, overlooking the fact, that at this same theoretic rate straw manure was worth 13s. per ton, or 50 per cent. more than its selling price, after due allowance was made for the expense of carting? The price of guano has been raised, the market disturbed, the buyer and seller put into antagonism one to the other, and the issue of a struggle injurious to both parties will alone decide whether the existing scale of guano-valuations was practically sound or not. Meanwhile the enhanced price of meat, the ample supplies of oil-cake drawn from all quarters, improvements in breeding and feeding cattle, and, it may be, in treating them under disease, all tend to lower the price of that costly constituent ammonia.

To come now to some particulars. The received standard values potash at 2d. per lb., and some authorities have set it as high as 3d. per lb. How is this conclusion arrived at? It may be that this element is essential for all our crops, that some soils are deficient in it, that it cannot be bought in any *commercial* form at a cheaper rate; but we farmers *do not buy it* in any such form. If some of our fields are deficient, we apply it in straw or in burnt clay ashes brought from other fields, probably at a much cheaper rate. If all are defective, we husband our resources, as we readily can do, or if our land has a good staple, we rely on the stores in the subsoil. No doubt potash has a considerable value, and an additional supply is often serviceable, and not always ready at hand; but still the farmer, I may say, never buys it, by itself and for itself, at commercial rates. Then, is it not rash to guess at a value of three or four times as high as that of insoluble phosphate in its best form? *

* On this point Liebig (in his preface to 'Letters on Modern Agriculture') admits that in the production of *corn and flesh*, the alkalies in the farmyard-manure remain in the field, and in the progress of cultivation their quantity rather increases than diminishes; and Professor Anderson, in 1857, whilst he valued

Another material point in these valuations is the difference of the value put on phosphate, according as it is classed as soluble or insoluble. It may be inferred from Dr. Voelcker's paper in this number of the Journal, that our authorities will reconsider this point, though it may not be easy to readjust it.

It seems to be now recognised that before becoming food for plants the phosphate resumes an insoluble form.

The value of phosphatic manures depends, then, not on the transient solubility, but on the fineness of the powder permanently produced, it being easy of assimilation in proportion to that fineness. If this be so, those particles which have recently been subjected to the influence of vital action, vegetable or animal, will be more available than such as have been turned into stone by Nature's alchemy; and yet these two classes of substances have of late been indiscriminately set at a lower value, as insoluble phosphates.

This mistake, if mistake it be, has also bred some practical harm, phosphatic guanos, when imported, not having met with the encouragement which they deserved, or having been treated with sulphuric acid at much cost, not so much to increase their value, as to adapt them to our market and our defective scale of valuation.

But if decomposition, not transformation or solution, be henceforth our object in dealing with phosphate, the important point to ascertain will be the *origin*, be it mineral or organic, of the material employed, and home manufacture may again be resorted to as the best guarantee that the materials are organic. The use of a small proportion of sulphuric acid may revive, in spite of great difficulty of transport, and even the warning that about the first 10 lbs. if used with 100 lbs. of bones only form gypsum, not superphosphate, may not be heeded, if a violent action can only be generated which shall result in reducing the mass to fine powder. The classification and pricing of phosphate seems, therefore, to call for some revision.

I am not disposed to quarrel with the customary valuation for organic matter, of 1*l.* per ton. This is so moderate that it may, perhaps, hardly meet the approval of those who sympathize with a late influential effort to resuscitate Old King Humus, who had gradually sunk into oblivion since the younger powers of earth—the children of Priestly, Cavendish, Davy, &c.—had torn the veil of mystery from that awful brow, and divided his substance. But it rests with his advocates to plead his cause.

Whatever, then, be the value of the excreta of the average man

potash at 20*l.* per ton, stated that from kelp it could be procured at 15*l.* per ton, together with other fertilizers worth 2*l.*

when priced at guano rates, since those rates give to farmyard-manure a value of 13s. per ton, it remains for the farmer who does not set so high a figure even on his good bullock-manure, to make a deduction accordingly, so as to reconcile the valuation with the prices of the times.

IX.—*On the Effects of different Manures on the Mixed Herbage of Grass-land.* By J. B. LAWES, F.R.S., F.C.S., and J. H. GILBERT, Ph. D., F.R.S., F.C.S.

In Vol. XIX., Part II., and Vol. XX., Parts I. and II. of this Journal, we gave a Report on Experiments with different manures on permanent meadow land, in which we treated of the subject under the following heads:—

Part I. The produce of hay, per acre.

Part II. The produce of constituents, per acre.

Part III. The description of plants developed by different manures.

Part IV. The chemical composition of the hay.

Perhaps the most striking points brought out in the inquiry, were those which illustrated the very great difference in the description and character of the plants developed by the different manures. The general results arrived at under this head, may be very briefly re-stated here.

The unmanured crops, and the light ones grown by manure, were by far the most complex in character; consisting of a comparatively large number of species of plants, or descriptions of herbage, and showing less predominance of a few species than did the more bulky produce obtained by means of more active manures. The smaller crops consisted not only of a greater variety of Gramineous herbage, or grasses properly so called, but also contained a greater variety and greater proportion of miscellaneous or weedy herbage.

As a rule, whatever the description of manure employed, any considerable increase of crop was accompanied by greater simplicity of herbage, greater predominance of grasses proper, and also, generally, a greater predominance of individual species, both among the Gramineous or grassy, the Leguminous, and the miscellaneous herbage.

But different descriptions of manure had very different effects.

Mineral manures alone (salts of potass, soda, magnesia, and superphosphate of lime) only moderately increased the amount of crop; rather diminished the proportion of the grasses, and

considerably that of the weedy herbage; greatly increased the amount per acre, and the proportion in the produce, of the Leguminous herbage, especially the perennial red clover and the meadow vetchling; and also enhanced the ripening tendency, rather than luxuriance of foliage.

Ammonia-salts alone, considerably increased the amount per acre, and the proportion in the crop, of the grasses, but tended very remarkably to the development of leaf rather than of stem and seed; and they also diminished the proportion of both the Leguminous and the weedy herbage, the former being almost excluded.

Mixtures of both the mineral manure and ammonia-salts, gave by far the greatest increase of crop. The produce so obtained was in a much larger proportion Graminaceous, or grassy, than that yielded under any other conditions; clover and other Leguminous plants were almost entirely excluded; and the number of species and amount of weedy herbage were but small, though some few plants grew luxuriantly. Lastly, comparatively few species of grasses contributed to the great bulk of this very luxuriant and highly Graminaceous produce, and the development of stem and seed was very remarkable.

Farm-yard manure alone, with the increase of total produce, also increased the amount and proportion of the Graminaceous herbage; and diminished the variety, and the proportion, of the Leguminous and the miscellaneous herbage.

Farm-yard manure and ammonia-salts gave considerably more increase of crop than farm-yard manure alone; and the produce contained a large proportion of Graminaceous and miscellaneous, but very little Leguminous herbage.

This great variety in the herbage, both as to the description of the plants developed, and the character of their growth, according to the manures employed, and to the consequent amount of crop obtained, is obviously a point of great practical interest and importance in its bearing upon the question of the proper manures to be employed to increase the produce of grass-land.

The results briefly enumerated above are also of great interest in another point of view.

Thus, exclusively mineral manures, when applied to Graminaceous plants grown separately (as wheat, barley, or oats, under ordinary circumstances), produce very similar effects to those upon the allied plants of the mixed herbage; that is to say, they increase the crop comparatively little, but prominently develop the seeding tendency; and again, when these manures are applied to Leguminous crops grown separately, as in the case of the allied plants of the mixed herbage, they considerably increase the luxuriance of their growth.

Ammonia-salts, on the other hand, which produce such characteristic effects upon the growth of the Gramineaceous plants of the mixed herbage, have also a marked influence upon that of the Gramineaceous plants grown separately in rotation, and but little on that of the Leguminous ones so grown.

For various reasons, therefore, both practical and scientific, it seemed very desirable that the subject should be further investigated, both here and elsewhere. The experiments at Rothamsted have, accordingly, been continued up to the present time, and they are still in progress.

Our first report, to which we have been referring, gave the results of the first three seasons (1856, 1857, and 1858), relating to three divisions of the subject, namely—the produce of hay per acre, the produce of constituents per acre, and the chemical composition of the hay—and on these points we have now on hand the accumulated results of four more seasons. The results formerly given on the remaining branch of the subject—the *description of plants developed by the different manures*—related to the produce of the third season only, 1858; and the further details obtained on this head have reference to the produce of the seventh season, 1862. It is to these that it is proposed to confine attention on the present occasion, presenting only such an outline of the voluminous records as will bring to view the points of most interest to the readers of an Agricultural Journal.

Method of Experimenting.

Taking advantage of the experience gained in some attempts to separate and determine the proportion of the different plants, in carefully averaged and weighed samples of the produce in the previous year (1857), the produce of 1858 had been separated into—(1) Gramineaceous herbage, stems bearing flower or seed; (2) Gramineaceous herbage, detached leaves and indeterminate stems; (3) Leguminous herbage; (4) Miscellaneous herbage, chiefly weeds. The components classified under these heads gave from 14 to 23 different descriptions of herbage; and, no doubt, the results, so far as they went, clearly and truthfully indicated the characteristic and comparative distribution of plants on the different plots. But as there remained, in the separations in question, an amount equal in several cases to a fourth, and in one to more than a half of the whole produce, to be set down as Gramineaceous herbage in “detached leaves and indeterminate stems,” to the components of which the specific names could not with any confidence be given, it seemed desirable, in again taking up the subject, to follow it out in considerably more of detail. Accordingly, in the separations recently made, of the produce of 1862,

it was sought to determine the species to which the detached leaves and imperfect stems belonged, and so to include in the amount given for each grass, as far as possible its total yield, whether in culm bearing flower and seed, or in a less definite condition. The classification of the Gramineaceous herbage will, therefore, on the present occasion, be somewhat different; and hence the present and the former results will not be strictly comparable.

It will be obvious that to conduct the work on the plan just indicated, not only involved an immense amount of labour, but required very considerable technical knowledge and experience in those superintending the separations. Accordingly, we applied to several botanical friends for a competent botanical assistant; and we have now to express our best thanks to Dr. J. D. Hooker, of Kew, for recommending to us Mr. W. Sutherland, a young man who, as foreman of the "Hardy Herbaceous ground" in the Kew Gardens, had had, to use Dr. Hooker's words, "the charge of a most extensive named collection of herbaceous plants (some 4-5000), including a good collection of grasses." We have also much satisfaction in bearing testimony to the competency of Mr. Sutherland for the work he undertook, and to the conscientious and assiduous manner in which he has performed his tedious and difficult task.

The mode of taking the samples for the botanical separations was as follows: eight or ten mowers were put upon the half-acre experimental plot, and small quantities of grass were taken immediately after the scythe from each swathe, until nearly the whole of the plot was down. The quantities so taken, amounting to very many times more than the required sample, were then carefully mixed on a cloth, so as to shake out as little seed as possible, and from the bulk a sample of 10 lbs. was immediately weighed, before any material change in the condition of the grass could take place by evaporation.

The samples taken as above described were spread out to dry at the ordinary temperature, and afterwards carefully preserved for future operation.

In all, twenty samples have been submitted to botanical analysis; occupying Mr. Sutherland for about four months, and another assistant, and from three to half a dozen boys, for a period of nearly six months.

The plan adopted in the first instance was to work down each sample to the point of something like equal difficulty of further separation. The remaining undetermined residue was then put into a sieve, and the larger stemmy and leafy portions were thus separated from the shedded flowers and seeds, and finely broken leafy matter. The mass of the latter was then separated, by

means of other sieves of varying fineness, into four or five different lots, in order to facilitate the examination and identification of its components; and notes were made accordingly as to their apparent character. But it was found that there still remained, in some cases, nearly one-fourth of the original sample as undetermined stemmy and leafy residue. Hence, all such residues that amounted to more than 10 per cent. of the original sample were afterwards submitted to a further separation—a most tedious labour—which, however, has in very few cases left as much as 10 per cent. of undetermined matter. Still, after these further separations, the relative proportions of the final stemmy and leafy residues will, to some extent indicate the ease or difficulty attending the separations and identifications, and at the same time, be some indication of the character of development of the herbage. For, it will be readily understood that a very luxuriant and stemmy Gramineous produce, would be much more easily separated into its components, than a mass consisting almost exclusively of leafy herbage. Indeed, whilst some of the individual samples required more than a week for the first, and afterwards some days for the second separation, others were worked much more easily.

The numerical results of the inquiry, showing the proportion per cent. in each sample, of each separated portion, are given in the large folding Table, facing p. 164; in which the individual plants, or descriptions of herbage otherwise defined, are classified into—

- 1.—Gramineous herbage :
 - Determined species ;
 - Undetermined stem and leaf ;
 - Shedded flowers and seeds, &c. (chiefly Gramineous).
- 2.—Leguminous herbage.
- 3.—Miscellaneous herbage.

And, as will be seen, the different plants composing the Miscellaneous or weedy herbage, are classified into the Natural Orders to which they respectively belong.

The following is a detailed statement of the manuring of the different plots; a brief description of which is given under the corresponding plot-numbers in the Tables. Unless otherwise stated, the same description and amount of manure has been applied to the respective plots every year since the beginning of the experiments in 1856. The quantities are given *per acre*.

Plot 1.—Unmanured.

Plot 2.—Unmanured (duplicate plot at the further end of the series).

Plot 3 *a*.—Superphosphate of lime; composed of 200 lbs. bone-ash, and 150 lbs. sulphuric acid of sp. gr. 1.7. 4th season, commencing in 1859; sawdust alone the three previous seasons.

Plot 3 *b*.—Superphosphate of lime; and 400 lbs. ammonia-salts (equal parts sulphate and muriate of commerce, supplying about 82 lbs. nitrogen per acre). 4th season, commencing in 1859; the three previous seasons sawdust alone.

Plot 4.—400 lbs. ammonia-salts.

Plot 5.—400 lbs. ammonia-salts; and 2000 lbs. sawdust.

Plot 6.—275 lbs. nitrate of soda of commerce (containing about 41 lbs. nitrogen). 5th season, commencing 1858.

Plot 7.—550 lbs. nitrate of soda (containing about 82 lbs. nitrogen). 5th season, commencing in 1858.

Plot 8.—Mixed mineral manure, composed of—

300 lbs. sulphate of potass.

200 lbs. sulphate of soda.

100 lbs. sulphate of magnesia.

Superphosphate of lime, as above.

Plot 9.—Mixed mineral manure; and 2000 lbs. sawdust. (The mixed mineral manure as Plot 8 to 1861 inclusive, and in 1862 the sulphate of potass excluded, and the amount of sulphate of soda raised to 500 lbs.)

Plot 10.—Mixed mineral manure, as Plot 8; and 400 lbs. ammonia-salts.

Plot 11.—Mixed mineral manure, as Plot 9; and 400 lbs. ammonia-salts.

Plot 12 *a*.—Mixed mineral manure, as Plot 8; 400 lbs. ammonia-salts; and 2000 lbs. cut wheat-straw.

Plot 12 *b*.—Duplicate of Plot 12 *a*, but rather sheltered on the west by trees.

Plot 13 *a*.—Mixed mineral manure, as Plot 8; and 800 lbs. ammonia-salts, equal about 164 lbs. nitrogen (only 400 lbs. ammonia-salts in 1859, 1860, and 1861).

Plot 13 *b*.—Mixed mineral manure, as Plot 13 *a*, to 1861 inclusive; the same with 200 lbs. silicate of soda and 200 lbs. silicate of lime in addition in 1862; and 800 lbs. ammonia-salts (only 400 lbs. ammonia-salts in 1859, 1860, and 1861).

Plot 14.—Mixed mineral manure, as Plot 8; and 275 lbs. nitrate of soda. 5th season, commencing in 1858.

Plot 15.—Mixed mineral manure, as Plot 8; and 550 lbs. nitrate of soda. 5th season, commencing in 1858.

Plot 16.—14 tons farm-yard manure.

Plot 17.—14 tons farm-yard manure ; and 200 lbs. ammoniacal salts,

With the view of both controlling and adding to the numerical results of the botanical separations, it was decided to have systematic series of notes taken on the ground. To this end, between three and four weeks prior to the date of cutting were devoted to making observations, as under :—

1. On each plot *seriatim* ; remarking the predominance, and character of development, of the different plants.

2. On each of the most important plants *seriatim* ; comparing its predominance, and character of development, on the different plots.

3. On the relative conditions of ripeness of the plots generally, and of individual descriptions of plants just before cutting.

Then, after the crop was cut, and before its removal from the ground, further notes were taken, with the full view of the produce of the entire plot then at command, the former ones having been made only at either end of the respective plots.

Lastly, notes on the second crop were taken.

In the separations of 1858, the number of species determined in any one sample in no case amounted to twenty ; the undetermined Gramineaceous herbage was, however, subdivided into four or five different lots, supplying, in addition to the defined species, so many different descriptions of herbage ; but in the separations of 1862, forty or more defined species were in some cases identified. It is not supposed that a greater number of plants occurred in the produce of 1862 than in that of 1858. The result is doubtless due to the much greater amount of attention and labour bestowed upon the more recent separations. There is, however, no doubt, that, although the more general characteristics of the herbage on the respective differently-manured plots remain the same as formerly—that is to say, as to the general predominance respectively of Gramineaceous, Leguminous, and Miscellaneous herbage, and tendency to stemmy or leafy development—yet that there is a considerably altered predominance of particular plants, as a further consideration of the results will show.

It is not proposed to comment in detail upon the numerical results given in the large folding Table (facing p. 164), nor to quote at any length from the voluminous written observations to which reference has been made, as such a treatment of the subject is more suitable to the pages of a Botanical than of an Agricultural Journal.

The most important practical points for consideration are those which illustrate the character of the herbage in relation to the manures employed, and to the amounts of crop yielded. In relation to these points, therefore, we shall briefly consider—

1. The general description, and proportion per cent., of the different kinds of herbage (Graminaceous, Leguminous, or Miscellaneous), and the number of species.

2. The description, and proportion per cent., of the predominating species.

3. The tendency to the development of leafy or stemmy produce, and the order of ripeness.

I.—*The general description, and proportion per cent., of the different kinds of herbage (Graminaceous, Leguminous, and Miscellaneous), and the number of species, in relation to the manures employed, and to the amounts of crop yielded.*

In Table II. (pp. 140-141), are given the results relating to this branch of the subject. On the left hand will be found a short description of the manures employed, and a column showing the average annual yield of hay per acre on each plot, reckoned from the commencement of the experiments to 1862 inclusive; the records for the plot giving the largest amount of produce standing at the head of the list, and so on, in order, according to the crop yielded. Side by side with these particulars, on their right, are given, for each plot, the proportion per cent. in the produce, of—

1.—Graminaceous herbage :

Determined species ;

Undetermined stem and leaf ;

Shedded flowers, seeds, &c., chiefly Graminaceous.

2.—Leguminous herbage.

3.—Miscellaneous or weedy herbage.

Also the number of species, respectively of the Graminaceous, the Leguminous, and the Miscellaneous herbage.

It will be seen that the average annual amount of produce at the head of the list is 6877 lbs., and that there is a pretty gradual diminution down to 2720 lbs., which is the yield without manure of any kind. The heaviest produce was obtained where, in conjunction with the mixed mineral manure, the largest amount of ammonia-salts (containing about 164 lbs. of nitrogen) was applied. Leaving out of consideration for the present the comparatively immaterial influence of cut wheat-straw, or sawdust, the next in order as to amount of crop are the five plots where, with the mixed mineral manure, half the quantity of nitrogen (about 82 lbs.), either in the form of ammonia-salts or nitrate of

soda, was used. Then come two plots, the one with about 41 lbs. nitrogen, supplied in the form of ammonia-salts, and the other with the same amount in the form of nitrate of soda; the former with farmyard dung manure in addition, containing, of course, besides a large amount of mineral constituents and carbonaceous organic matter, a considerable quantity of nitrogen; the latter with the mixed mineral manure. Next comes the plot with ammonia-salts (= 82 lbs. nitrogen) and superphosphate of lime instead of the mixed mineral manure, showing a deficiency of produce, due to the exclusion of the alkaline salts, of 1200 lbs. to 1400 lbs. per acre per annum. Still, this obviously defective combination gives more produce than an annual dressing of 14 tons of farmyard manure per acre, with all its mineral and carbonaceous organic matter, and a good deal of nitrogen also. Nitrate of soda alone = 82 lbs. nitrogen, stands next to farmyard manure alone, giving more produce than the mixed mineral manure alone; which, in its turn, gives slightly more than ammonia-salts alone = 82 lbs. nitrogen, or nitrate of soda alone = 41 lbs. nitrogen, and considerably more than superphosphate of lime alone. But although the mixed mineral manure alone gave more total produce than the ammonia-salts alone (= 82 lbs. nitrogen), it in point of fact gave very much less of Gramineous herbage, its increase consisting in very large proportion of Leguminous plants.

The general result is, then, that the largest amounts of gross produce were obtained where the largest amounts of nitrogen were applied in the manure; provided only, that a sufficiency of mineral constituents was at the same time supplied. Further, that much larger crops were obtained by means of artificial manures supplying nitrogen and mineral constituents, than by a heavy dressing of farmyard manure, with all its carbonaceous organic matter in addition to its large amount of nitrogen and mineral constituents. And again, a complex mineral manure alone, gave about as much total produce as ammonia-salts alone or nitrate of soda alone; but the description of herbage developed was very different in the two cases.

Let us now consider the varying character of the herbage coincident with the use of such very different descriptions of manure, and the production of such very varying amounts of crop.

A glance at the Table (II.) shows that with the highest amount of produce there was the highest proportion in it of Gramineous herbage = about 95 per cent., no Leguminous herbage whatever, and the lowest proportion of Miscellaneous herbage = not quite 5 per cent. There was also with the lowest amount of produce only about 74 per cent. of Gramineous herbage (which is almost

TABLE II.—Showing the General Description, and Proportion per Cent., of the employed, and to the amounts of Crop

Plot Nos.	General Description of Manures.	Hay, per Acre per Annum; average of 7 Years, 1856-62.	GENERAL DESCRIPTION	
			Per Cent.	
			Graminaceous.	
			Determined Species.	Undetermined Stem and Leaf.
13b	Ammonia-salts = 164 lbs. nitrogen, and mixed mineral manure, including silicates	6877	81.95	8.88
13a	Ammonia-salts = 164 lbs. nitrogen, and mixed mineral manure (without silicates)	6876	80.91	5.69
10	Ammonia-salts = 82 lbs. nitrogen, and mixed mineral manure	6357	77.57	6.31
11	Ammonia-salts = 82 lbs. nitrogen, and mixed mineral manure (excluding potass in 1862), and sawdust	6216	72.97	8.91
12a	Ammonia-salts = 82 lbs. nitrogen, mixed mineral manure, and 2000 lbs. cut wheat-straw	6159	80.61	6.52
12b	Duplicate of plot 12a (half of the plot rather sheltered by trees)	6141	74.39	12.69
15	Nitrate of soda = 82 lbs. nitrogen, and mixed mineral manure	5783*	67.39	12.65
17	Ammonia-salts = 41 lbs. nitrogen, and farmyard manure	5468	73.48	5.82
14	Nitrate of soda = 41 lbs. nitrogen, and mixed mineral manure	4939*	65.78	8.27
3b	Ammonia-salts = 82 lbs. nitrogen, and superphosphate of lime	4877†	69.45	6.40
16	Farmyard manure, alone	4775	60.33	7.88
7	Nitrate of soda, alone = 82 lbs. nitrogen	4126*	52.34	17.65
9	Mixed mineral manure (excluding potass in 1862), and sawdust	4100	65.21	4.40
8	Mixed mineral manure, alone	3919	56.47	5.83
5	Ammonia-salts = 82 lbs. nitrogen, and sawdust	3839	77.43	1.59
6	Nitrate of soda, alone = 41 lbs. nitrogen	3805*	57.27	14.61
4	Ammonia-salts, alone = 82 lbs. nitrogen	3719	78.68	5.07
3a	Superphosphate of lime, alone	3164†	62.36	8.90
2	Unmanured	2927	58.13	11.61
1	Unmanured	2720	58.82	7.43

* Average of 5 years only, 1858-62 inclusive.

† Average of 4 years only, 1859-62 inclusive.

different kinds of Herbage, and the Number of Species, in relation to the Manures yielded. SEVENTH SEASON, 1862.

OF HERBAGE.

Per Cent.				Number of Species.			
Gramineous.		Leguminous.	Miscellaneous.	Gramineous.	Leguminous.	Miscellaneous.	Total.
Shedded Flowers and Seeds, &c., chiefly Gramineous.	Total.						
4.19	95.02	0.00	4.98	14	0	7	21
3.81	90.41	0.00	9.59	15	0	9	24
5.78	89.66	0.12	10.22	14	2	12	28
4.96	86.84	0.13	13.03	15	2	13	30
3.25	90.38	0.46	9.16	14	2	13	29
5.06	92.14	0.02	7.84	14	2	10	26
9.71	89.75	0.86	9.39	13	2	10	25
10.28	89.58	0.21	10.21	16	4	8	28
5.64	79.69	1.92	18.39	15	3	13	31
7.63	83.48	0.11	16.41	13	3	16	32
10.86	79.07	1.72	19.21	13	3	11	27
10.32	80.31	0.17	19.52	16	2	10	28
3.97	73.58	18.28	8.14	16	4	16	36
4.10	66.40	24.09	9.51	17	4	19	40
3.25	82.27	0.24	17.49	16	4	15	35
12.34	84.22	0.32	15.46	16	3	13	31
4.59	88.34	0.15	11.51	16	3	14	33
7.46	78.72	2.60	18.68	16	4	19	39
4.25	73.99	6.16	19.85	15	3	20	38
7.95	74.20	7.61	18.19	16	4	23	43

almost the lowest proportion), about 7 per cent. of Leguminous herbage, and nearly the highest proportion of Miscellaneous or weedy herbage.

Again, whilst the smallest number, or only 21 species of plants, was discovered in the sample of the heaviest produce, the largest number, or 43 species, was found in that of the smallest produce.

These extreme results prominently bring to view the fact, that with large produce there was an almost exclusively Gramineous, and a comparatively simple herbage; and that with small produce the herbage was at once much less Gramineous, and much more complex. There is, moreover, with some instructive exceptions to which attention will be directed, something like a gradual decrease in the proportion of Gramineous, and increase in that of the Miscellaneous herbage, and especially in the number of species, as we proceed from the larger to the smaller crops.

Taking the results given in the Table a little more in detail, it will be well to bear in mind the general character of the herbage on the unmanured land, as the standard by which to compare that on the variously manured plots.

The unmanured produce, taking the mean result of the two plots, consisted, in round numbers, of about 74 per cent. Gramineous, 6 to 7 per cent. Leguminous, and about 19 per cent. Miscellaneous herbage; and it comprised about 40 species of plants.

In contrast with the above composition, that of the six or seven heaviest crops at the head of the list in the Table (II.) may be taken, in round numbers, at from about 90 to 95 per cent. Gramineous, from 0 to 0.86 per cent. Leguminous, and from 5 to something over 10 per cent. Miscellaneous herbage; the number of species varying from 21 to 30.]

Comparing these heavier crops with one another, it is interesting to observe that Plot 13 *b*, manured with ammonia-salts and a mineral manure including silicates, gave a higher percentage of Gramineous, and a lower percentage of Miscellaneous herbage, than Plot 13 *a*, with otherwise the same manure but excluding silicates. Again, Plot 10 with ammonia-salts and mineral manure including potass, gave rather more produce, and a rather higher proportion of Gramineous herbage, than Plot 11, with the same amount of ammonia-salts, and otherwise the same mineral manure (and sawdust in addition), but excluding potass. Plot 10 also gave rather more produce than either Plot 12 *a* or Plot 12 *b*, which had the same amount of ammonia-salts and mineral manure, with 2000 lbs. of cut wheat-straw per acre per annum in addition, though these plots with the cut wheat-straw gave a slightly higher proportion of Gramineous herbage.

Plot 15, with the same mineral manure as Plot 10, and with

about the same amount of nitrogen, but in the form of nitrate of soda instead of ammonia-salts, gave considerably less produce but almost exactly the same proportion of Gramineous herbage, and more Leguminous herbage (0·86 per cent.), than any of the plots manured with ammonia-salt.

The better adaptation of nitrate of soda than ammonia salts as a manure for Leguminous plants, a fact which we have in other cases observed, is again seen in the results of Plot 14. In that case, with a smaller amount of nitrate of soda and the mixed mineral manure, the Leguminous herbage amounted to nearly 2 per cent. of the produce. There was, at the same time, a larger proportion of Miscellaneous or weedy herbage (18·39 per cent.), and consequently a smaller proportion of the Gramineous, than in any other case with an equally bulky crop. Ammonia-salts, even in conjunction with farmyard-manure, increased the proportion of Gramineous plants at the expense of the Leguminous and Miscellaneous herbage.

Farmyard-manure alone increased the proportion of the Gramineous at the expense of the Leguminous herbage, the proportion of Miscellaneous herbage remaining about the same, though its character was very different, there being much fewer species and much greater predominance of individual weeds. In fact, under the influence of farmyard-manure there were fewer species developed within each division—Gramineous, Leguminous, and Miscellaneous—the manured crop affording only 27 species, against 38 in one case, and 43 in another, without manure.

Perhaps the most striking of the results recorded in the Table is that obtained on Plot 8, by means of the mixed mineral manure alone. Whereas, without manure we have 74 per cent. Gramineous, 6 to 7 per cent. Leguminous, and nearly 20 per cent. Miscellaneous herbage; and with the mixed mineral manure, *and ammonia-salts in addition*, 90 to 95 per cent. of the produce Gramineous, either no Leguminous herbage at all, or but a fraction of 1 per cent. of it, and 5 to 10 per cent. of Miscellaneous herbage; we have, with mixed mineral manure *alone*, only about 66½ per cent. of Gramineous herbage, as much as 24 per cent. Leguminous herbage, and only about 9½ per cent. Miscellaneous. Thus, two-thirds only of the produce by the mixed mineral manure alone consisted of grasses, whilst nearly one-fourth of it consisted of clovers, meadow vetchling, and trefoil. The number of species was, however, about as high as without manure, and very much higher than with the same mineral manure and ammonia-salts in addition.

As already alluded to, when such mineral manures are applied to crops grown separately as in rotation, instead of together in a

mixed herbage, they generally increase the produce of Graminaeous ones but little, and that of Leguminous ones very characteristically. It has been found, too, that even in a clayey soil, the constituent of mineral manures which seems to have the most influence upon the growth of the Leguminous plants of rotation, beans and clover for example, was potass; and we have in the results under consideration a striking instance of the effects produced on the growth of the allied plants of the mixed herbage by a liberal supply to the soil of that constituent. Thus, Plot 9 had in every previous year of the experiments received the same description and amount of mineral manure as Plot 8, but in 1862 the potass was excluded (from Plot 9), and a larger amount of soda-salt substituted. The result was that the produce of Plot 9, without the potass, gave only 18 instead of 24 per cent. of Leguminous herbage, or only three-fourths as high a proportion as that of the plot manured otherwise similarly, but with the potass in addition.

Superphosphate of lime alone, used for a series of years, has somewhat increased the amount and proportion of the grasses, at the expense of the Leguminous plants; the proportion of the Miscellaneous herbage remaining about the same. Still, the proportion of the Leguminous herbage under the influence of this manure, though considerably less than without manure, and little more than one-tenth as great as with the mixed mineral manure (containing salts of potass, soda, and magnesia, as well as superphosphate of lime), was considerably greater than in any case where either ammonia-salts or nitrates were used, whether they were employed alone, in combination with mixed mineral, or with farmyard-manure.

Lastly, ammonia-salts alone (or with only sawdust in addition), or nitrate of soda alone, considerably increased the proportion of the grasses, almost excluded the Leguminous herbage, reduced the proportion of Miscellaneous plants, and also the total number of species.

It will perhaps be remembered that some years ago Baron Liebig stated he had obtained marked effects by the use of sawdust as a manure; a result which he considered due to the evolution of carbonic acid from the decomposing sawdust, by means of which the supply of mineral constituents within the soil was rendered more rapidly available.

We have, therefore, for some years past, applied 2000 lbs. of sawdust per acre, per annum, to a few of the experimental plots. Where, in previous years, the sawdust was used alone, with mineral manure without ammonia-salts, or with ammonia-salts without mineral manure, some, but generally a very small increase of produce, has been the result. But where the sawdust has been

employed with both mineral manure and ammonia-salts, that is to say with a combination itself yielding a pretty full increase of produce, no further increase has been obtained by its means. Nor has the use, annually, of 2000 lbs. of finely-cut wheat-straw, in addition to the mixture of mineral manure and ammonia-salts, had as yet any beneficial effect upon the amount of gross produce per acre, notwithstanding the large amount of mineral matter peculiarly adapted for the growth of Gramineous plants, which, in addition to its decomposing carbonaceous substance, it would in the course of time supply.

Sawdust has, for similar reasons, also been tried on some of the crops grown on land under tillage, and with equal failure of beneficial result.

So far as observation goes, the effects of sawdust have been as immaterial on the character of the mixed herbage as on its amount; but as in the past season, 1862, in two out of the three cases where sawdust was employed potass was excluded from the mixed mineral manure used with it, the results are not, in the season in question, strictly comparable with those of the plots with which they had previously been compared, but which now differ not only in not having sawdust, but in having potass. The only strictly comparable experiments in 1862 are that of Plot 4 with ammonia-salts alone, and that of Plot 5 with the same amount of ammonia-salts, and sawdust in addition; and, so far as the figures go, it would appear that the sawdust somewhat reduced the proportion of the grasses, and increased that of the Miscellaneous or weedy herbage.

We now turn to a consideration of the next branch of the subject.

II.—*The description, and proportion per cent., of the predominating species, in relation to the manures employed, and to the amounts of crop yielded.*

Table III. (pp. 146-147) illustrates this branch of the subject. As in Table II., the plots are arranged in order according to the amount of produce, the one yielding the most being at the head of the list, and so on. The particulars given relating to the predominating plants are—

1. The names, and proportion per cent., of the 5 predominating Gramineous plants, or genera.
2. The names, and proportion per cent., of the 2 predominating Leguminous plants, or genera.
3. The same particulars for the 3 predominating Miscellaneous or weedy plants.

Although it is believed that the figures in the various Tables
VOL. XXIV. L may

TABLE III.—Showing the Description, and Proportion per Cent., of the predominating
SEVENTH

ORDER OF MOST PRODUCE, PER ACRE.			DESCRIPTION, AND PER CENT.			
Plot Nos.	General Description of Manures.	Hay, per Acre per Annum; average of 7 Years, 1856-62.	The Five predominating			
		lbs.	1	2	3	4
13b	Ammonia-salts = 164 lbs. nitrogen, and mixed mineral manure (including silicates)	6877	Dactylis gl. 21·9	Agrostis vul. 19·3	Poa tr. & pr. 14·3	Holcus lan. 7·0
12a	Ammonia-salts = 164 lbs. nitrogen, and mixed mineral manure (without silicates)	6876	Dactylis gl. 20·6	Poa tr. & pr. 16·6	Agrostis vul. 9·2	Holcus lan. 8·8
10	Ammonia-salts = 82 lbs. nitrogen, and mixed mineral manure	6357	Avena p. & f. 18·1	Poa tr. & pr. 12·7	Lolium per. 11·9	Agrostis vul. 11·6
11	Ammonia-salts = 82 lbs. nitrogen, and mixed mineral manure (excluding potass in 1862), and sawdust	6216	Avena p. & f. 19·2	Dactylis gl. 11·9	Poa tr. & pr. 9·1	Holcus lan. 8·6
12a	Ammonia-salts = 82 lbs. nitrogen, mixed mineral manure, and 2000 lbs. cut wheat-straw	6139	Dactylis gl. 20·6	Avena p. & f. 12·6	Agrostis vul. 12·0	Poa tr. & pr. 9·0
12b	Duplicate of Plot 12a (half of the plot rather sheltered by trees)	6141	Dactylis gl. 31·0	Poa tr. & pr. 12·0	Holcus lan. 6·3	Festuca p. & d. 6·3
15	Nitrate of soda = 82 lbs. nitrogen, and mixed mineral manure	5783*	Poa triv. 17·1	Dactylis gl. 11·6	Lolium per. 10·0	Bromus mol. 9·4
17	Ammonia-salts = 41 lbs. nitrogen, and farmyard manure	5468	Poa tr. & pr. 29·3	Dactylis gl. 10·9	Bromus mol. 12·3	Holcus lan. 6·0
14	Nitrate of soda = 41 lbs. nitrogen, and mixed mineral manure	4939*	Avena f. & p. 17·8	Festuca d. & p. 11·4	Agrostis vul. 10·3	Holcus lan. 9·6
2b	Ammonia-salts = 82 lbs. nitrogen, and superphosphate of lime	4877†	Agrostis vul. 18·6	Holcus lan. 15·3	Avena p. & f. 8·4	Poa triv. 7·3
16	Farmyard manure, alone	4775	Poa triv. 27·4	Bromus mol. 9·6	Avena p. & f. 7·3	Dactylis gl. 4·9
7	Nitrate of soda alone = 82 lbs. nitrogen	4120*	Festuca d. & p. 10·0	Alopecurus pr. 6·9	Agrostis vul. 6·2	Avena p. & f. 6·0
9	Mixed mineral manure (excluding potass in 1862), and sawdust	4100	Avena p. & f. 17·7	Festuca d. & p. 9·9	Agrostis vul. 7·6	Lolium per. 7·0
8	Mixed mineral manure, alone	3919	Avena p. & f. 16·7	Festuca d. & p. 12·8	Poa tr. & pr. 6·7	Arrhenathera 5·3
5	Ammonia-salts = 82 lbs. nitrogen, and sawdust	3889	Agrostis vul. 20·5	Avena p. & f. 16·6	Festuca d. & p. 14·4	Holcus lan. 8·1
6	Nitrate of soda, alone = 41 lbs. nitrogen	3805*	Alopecurus pr. 19·7	Festuca d. & p. 8·0	Agrostis vul. 6·8	Holcus lan. 6·7
4	Ammonia-salts, alone = 82 lbs. nitrogen	3719	Festuca d. & p. 23·3	Agrostis vul. 21·3	Holcus lan. 9·7	Avena p. & f. 5·3
2a	Superphosphate of lime, alone	3164†	Avena p. & f. 12·5	Festuca d. & p. 12·2	Holcus lan. 11·9	Lolium per. 9·5
2	Unmanured	2927	Festuca p. & d. 16·2	Avena p. & f. 11·3	Agrostis vul. 5·5	Dactylis gl. 5·2
1	Unmanured	2720	Festuca p. & d. 13·9	Avena p. & f. 11·0	Lolium per. 8·7	Agrostis vul. 5·6

* Average of 5 years only, 1858-62 inclusive.

† Average of 4 years only, 1859-62 inclusive.

Species, in relation to the Manures employed, and to the Amounts of Crop yielded.
SEASON, 1862.

OF PREDOMINATING SPECIES.

Gramineaceous Plants.		The Two predominating Leguminous Plants.			The Three predominating Miscellaneous Plants.			
5	Total per Cent.	1	2	Total per Cent.	1	2	3	Total per Cent.
<i>Arrhenath. av.</i> 5-7	68-2	0-00	0-00	0-00	<i>Rumex acet.</i> 3-72	<i>Carum Car.</i> 0-82	<i>Achillea mil.</i> 0-39	4-93
<i>Lolium per.</i> 8-6	66-8	0-00	0-00	0-00	<i>Rumex acet.</i> 6-40	<i>Achillea mil.</i> 1-53	<i>Carum Car.</i> 1-35	9-28
<i>Holcus lan.</i> 11-1	65-4	<i>Lathyrus pr.</i> 0-11	<i>Trifolium rep.</i> 0-01	0-12	<i>Rumex acet.</i> 4-36	<i>Carum Car.</i> 2-34	<i>Achillea mil.</i> 1-36	9-23
<i>Agrostis vul.</i> 8-0	56-8	<i>Lathyrus pr.</i> 0-12	<i>Trifolium rep.</i> 0-01	0-13	<i>Rumex acet.</i> 9-26	<i>Carum Car.</i> 1-47	<i>Achillea mil.</i> 0-90	11-63
<i>Lolium per.</i> 7-5	64-7	<i>Lathyrus pr.</i> 0-41	<i>Trifolium pr.</i> 0-05	0-46	<i>Rumex acet.</i> 4-88	<i>Achillea mil.</i> 2-08	<i>Carum Car.</i> 1-74	8-70
<i>Avena p. & f.</i> 6-0	61-6	<i>Lathyrus pr.</i> 0-01	<i>Trifolium rep.</i> 0-01	0-02	<i>Rumex acet.</i> 5-36	<i>Carum Car.</i> 1-33	<i>Achillea mil.</i> 0-75	7-64
<i>Holcus lan.</i> 6-7	51-8	<i>Lathyrus pr.</i> 0-34	<i>Trifolium pr.</i> 0-02	0-86	<i>Rumex acet.</i> 7-09	<i>Carum Car.</i> 1-09	<i>Ranun. a. & b.</i> 0-53	8-70
<i>Avena f. & p.</i> 3-8	68-7	<i>Lathyrus pr.</i> 0-14	<i>Trifolium pr.</i> 0-05	0-19	<i>Rumex acet.</i> 5-76	<i>Achillea mil.</i> 1-39	<i>Ranun. a. & b.</i> 1-39	8-54
<i>Poa triv.</i> 7-3	56-1	<i>Trifol. p. & r.</i> 1-87	<i>Lathyrus pr.</i> 0-05	1-92	<i>Rumex acet.</i> 5-33	<i>Ranun. a. & b.</i> 5-13	<i>Carum Car.</i> 3-75	14-26
<i>Festuca d. & p.</i> 6-9	56-5	<i>Lathyrus pr.</i> 0-07	<i>Trifol. p. & r.</i> 0-04	0-11	<i>Rumex acet.</i> 11-05	<i>Ranun. a. & b.</i> 1-73	<i>Achillea mil.</i> 1-70	14-48
<i>Arrhenath. av.</i> 2-7	51-9	<i>Lathyrus pr.</i> 0-90	<i>Trifol. p. & r.</i> 0-82	1-72	<i>Rumex acet.</i> 10-33	<i>Ranun. a. & b.</i> 2-34	<i>Achillea mil.</i> 2-53	15-01
<i>Lolium per.</i> 4-6	39-7	<i>Trifolium pr.</i> 0-16	<i>Lotus cornic.</i> 0-01	0-17	<i>Plantago lanc.</i> 6-99	<i>Rumex acet.</i> 5-72	<i>Achillea mil.</i> 2-55	15-26
<i>Arrhenath. av.</i> 5-1	47-3	<i>Trifol. p. & r.</i> 10-01	<i>Lathyrus pr.</i> 5-10	18-11	<i>Rumex acet.</i> 1-70	<i>Carum Car.</i> 1-29	<i>Achillea mil.</i> 0-93	4-04
<i>Holcus lan.</i> 4-9	46-4	<i>Lathyrus pr.</i> 13-24	<i>Trifolium pr.</i> 7-51	20-75	<i>Rumex acet.</i> 1-86	<i>Carum Car.</i> 1-79	<i>Achillea mil.</i> 1-69	5-34
<i>Lolium per.</i> 3-8	65-4	<i>Lathyrus pr.</i> 0-22	<i>Trifolium pr.</i> 0-01	0-23	<i>Rumex acet.</i> 10-64	<i>Achillea mil.</i> 3-37	<i>Gallum ver.</i> 0-95	14-96
<i>Poa tr.</i> 5-7	46-9	<i>Trifolium pr.</i> 0-28	<i>Lotus cornic.</i> 0-03	0-31	<i>Centaurea nig.</i> 3-93	<i>Plantago lanc.</i> 3-06	<i>Rumex acet.</i> 2-84	9-83
<i>Arrhenath. av.</i> 5-8	68-6	<i>Lotus cornic.</i> 0-07	<i>Trifolium pr.</i> 0-07	0-14	<i>Rumex acet.</i> 7-85	<i>Achillea mil.</i> 1-33	<i>Carum Car.</i> 0-86	10-07
<i>Poa tr. & pr.</i> 5-7	51-8	<i>Trifol. p. & r.</i> 1-93	<i>Lotus cornic.</i> 0-09	2-32	<i>Plantago lanc.</i> 5-45	<i>Ranun. a. & b.</i> 4-27	<i>Rumex acet.</i> 3-17	12-79
<i>Holcus lan.</i> 4-3	43-0	<i>Trifolium pr.</i> 2-66	<i>Lathyrus pr.</i> 1-88	4-54	<i>Plantago lanc.</i> 7-72	<i>Rumex acet.</i> 2-68	<i>Carum Car.</i> 2-52	12-92
<i>Holcus lan.</i> 5-0	47-2	<i>Trifol. p. & r.</i> 4-73	<i>Lotus cornic.</i> 1-69	6-42	<i>Plantago lanc.</i> 6-87	<i>Ranun. a. & b.</i> 3-61	<i>Luxia camp.</i> 1-54	12-03

may be fully relied upon as showing the general relation to one another of the individual species, or different orders of plants, it is by no means supposed that small numerical differences, or even in all cases greater ones, are to be taken unconditionally as representing corresponding differences in the character of the herbage. It will be readily understood that in any case, and especially in that of a very heavy and luxuriant crop, there must be great difficulty in collecting a sample of no more than some ten pounds weight which will absolutely represent the bulk of the mixed herbage. Then again, the difficulty of separation and identification in the case of a mass of ill-defined and mutilated leafy produce is extremely great. It was with a full appreciation of these difficulties that we felt it necessary, if for no other reason than as a means of control over the numerical results, that the several series of notes to which reference has been made should be taken. And although the botanical separations have been conducted at the cost of an immense amount of care and labour, we shall, in the few remarks we have to make on the results on the present occasion, be guided by a careful consideration of the recorded observations, as well as of the figures given in the tables.

Taking the distribution of plants in the produce of the unmanured land as the standard by which to compare that of the other plots, attention will be directed in some detail to its components.

The Unmanured produce.

Sixteen Gramineous species were identified in the unmanured produce, constituting together about 74 per cent. of its weight; and although their distribution was more even than in most of the cases of the manured land, the species of the five predominating genera amounted in one case to 43 and in another to 47 per cent. of the total produce. In the produce of the heaviest crops, however, generally over 60, and sometimes as much as 68 or 69 per cent. were referable to the five predominating species, or at any rate to the species included within the five predominating genera.

In the unmanured produce, *Festuca duriuscula*, or *F. pratensis*, which are hardy and good grasses, *Avena pubescens* and *A. flavescens*, sweet and good grasses, adapted to dry and chalky land, and much liked in hay, were the most prominent; but they were by no means in such large proportion as the predominating grasses on most of the manured plots. Next to these were *Lolium perenne*, a very good and free-growing grass; *Agrostis vulgaris*, a creeping-rooted plant, said to be not liked by cattle; and *Holcus lanatus*, also a bad food-grass, being too soft and woolly. After these came *Arrhenatherum avenaceum*, a rather favourite

grass as early feed, and for its second cut; *Poa trivialis*, also a good grass for early feed and second crop, but from its tufty growth and strong creeping roots said to be apt to banish other grasses; *Anthoxanthum odoratum*, a fragrant grass, but not relished in large quantity; and *Alopecurus pratensis*, better as green food than as hay. All the above were more evenly distributed in the small unmanured produce than in any other; and it contained besides, insignificant quantities of *Dactylis glomerata*, a bulky and free-growing grass under favourable conditions, and much liked by stock when not too old; *Briza media*, a plant of limited growth, and not much relished as food; *Cynosurus cristatus*, varying in character considerably, according to circumstances of growth, better for pasture than for hay, but upon the whole of little utility; and lastly *Bromus mollis*, a soft and very bad food-grass.

It is true that on one of the unmanured plots (No. 2) *Dactylis glomerata* occurred in notable quantity; but as that plot was situated between plots 12 *a* and 13 *b*, on both of which *Dactylis* was very luxuriant, it is more probable that it has, from time to time, been seeded from them, than that such a grossly-feeding grass flourished naturally on the unmanured land. Observation, indeed, led to the conclusion that in some other cases unexpected differences in the indications of the figures are attributable to adventitious circumstances of an allied kind.

Of Leguminous herbage, the unmanured produce contained from 6 to 7 per cent., the larger portion of which consisted of perennial red clover, with a little white clover. *Lathyrus pratensis* (meadow vetchling), and *Lotus corniculatus* (bird's-foot trefoil) occurred in less quantity, but the two about equally, and more largely than in any other case excepting where the mixed mineral manures were employed.

The Miscellaneous or weedy herbage, of which nearly 20 per cent. of the unmanured produce was composed, also consisted, like the Gramineous herbage, of a great variety of species, of which few specially predominated, excepting the *Plantago lanceolata* (ribwort plantain). The next in prominence were the *Ranunculus acris* and *R. bulbosus* (crowfoots), *Rumex acetosa* (sorrel dock), *Carum Carui* (common caraway), *Achillæa millefolium* (milfoil), and *Luzula campestris* (field wood-rush). In smaller quantity occurred—of the Order *Compositæ*—*Centaurea nigra* (black knapweed), *Leontodon hispidus* (rough hawkbit), *Tragopogon pratense* (yellow goat's beard), *Taraxacum Dens-leonis* (dandelion), *Hypochaeris radicata* (cat's-ear), and *Bellis perennis* (daisy); of the Order *Umbelliferae*, *Pimpinella saxifraga* (burnet saxifrage), and *Heracleum sphondylium* (hogweed); and of plants of various other natural Orders, occurring still less pre-

valently, were the *Veronica chamædrys* (germander speedwell), *Cerastium vulgatum* (mouse-ear chickweed), *Stellaria graminea* (lesser starwort), *Scabiosa arvensis* (field scabious), *Hypnum squarrosum* (squarrose moss), *Primula veris* (cowslip), *Sanguisorba officinalis* (great burnet), *Geum urbanum* (common avens), *Galium verum* (yellow bed-straw), *Ajuga reptans* (bugle), and *Ophioglossum vulgatum* (adder's tongue). And there were probably others of too unpretending and restricted growth to be observed on the ground, or to come within reach of the scythe.

Upon the whole the unmanured produce—Graminaceous, Leguminous, and Miscellaneous—was more complex, and less characterised by the prevalence of individual species, than that of any of the manured plots. The most predominating plants were, of the grasses *Festuca duriuscula* and *F. pratensis*, *Avena pubescens* and *A. flavescens*; and of the Miscellaneous or weedy plants, *Plantago lanceolata*.

It is only necessary to add that the meadow yielding the mixed herbage composed as above described, though giving hay of fair average quality, and useful after-feed for store stock, or sheep, by no means partakes of the character of a fattening pasture.

Effects of Mineral Manures alone.

The plots on which the Graminaceous herbage more nearly approached to that of the unmanured land, both in complexity and in general prevalence of the same species, were plot 3 *a* manured with superphosphate of lime alone, and plots 8 and 9 with the mixed mineral manure. The chief distinctions apparent are, that by superphosphate of lime alone the inferior grass *Holcus lanatus* was brought into somewhat greater prominence, and that by it, as well as by the mixed mineral manure alone, the useful grass *Poa trivialis* was somewhat increased in relative amount. By the mixed mineral manure, *Arrhenatherum avenaceum* also appears to be somewhat encouraged. The free growing and bulky *Dactylis glomerata* was in very small quantity on either of the plots manured with mineral manure alone; nor are either of the other grasses which occur in predominating amount on one or other of the plots yielding the heavier crops, found at all prominently in the comparatively small produce grown under the influence of mineral manures alone.

It was on the amount and character of the Leguminous herbage that the mineral manures alone produced the most striking effects. Superphosphate of lime alone, considerably reduced the proportion of such herbage; but when with it salts of potass, soda, and magnesia were used, *Trifolium pratense* perenne, and *Lathyrus pratensis*, were developed in an extraordinary degree. When the

mixed mineral manure contained potass, as well as soda and magnesia (plot 8), the *Lathyrus* somewhat predominated; and where the potass was excluded (plot 9) it was in a smaller proportion. *Lotus*, again, was more abundant on plot 8, where the potass was employed. As already alluded to, however, the total amount of Leguminous herbage was very much the less on plot 9, where the potass was excluded; and as at present it has only been for one season excluded, it is not improbable that the proportion of such herbage will in future be greatly reduced. It is worthy of remark, too, that on plot 8, where the application of potass is continued, the proportion of Leguminous herbage was almost exactly the same in the produce of the seventh year of the experiments, 1862, as it had been found to be in that of the third season, 1858.

Superphosphate of lime alone, which tended to decrease the proportion of Leguminous plants, seemed to be generally favourable to the development of the Miscellaneous ones, both the variety and amount of such herbage being considerable. The proportion of *Plantago lanceolata* was nearly as great as on the unmanured plot, and that of *Ranunculus (acris and bulbosus)*, *Rumex*, *Achillæa*, and *Carum Carui*, was also comparatively large. On the other hand, the mixed mineral manures, which so much increased the proportion of the Leguminous plants, considerably diminished that of the Miscellaneous ones. The variety of such herbage was, however, considerable; the reduction in amount being due to the diminished luxuriance of several species, and especially the *Plantago*, which was in very small amount.

Effects of Ammonia-Salts alone.

Compared with the unmanured produce, ammonia-salts alone, or with sawdust only in addition, considerably increased the proportion of total Gramineous herbage, and also the amount referable to the species of the five predominating genera, the latter reaching from 65 to 68 per cent. of the total produce. To a great extent, however, the same grasses prevailed as in the small crops without manure, or with mineral manures alone. The most prominent effect of this relatively excessive nitrogenous condition, was the encouragement of the *Festuca duriuscula* and *Avena pubescens*, two good elements predominating in the produce without manure; to a greater extent still that of the objectionable creeping-rooted *Agrostis*; and in some degree also that of the inferior *Holcus lanatus*. Compared with the effects on the distribution of the Gramineous herbage of mineral manure alone, the most marked result of the ammonia-salts alone was the great increase of the *Agrostis* and the *Holcus*, at the

expense, to some extent, of the superior *Poa trivialis*, but in a greater degree of the Leguminous herbage. The free growing and bulky *Dactylis*, as by mineral manures alone, so also by ammonia-salts alone (which characteristically favour the growth of Gramineous herbage generally), appears to be kept in the background. In fact, although the increase by ammonia-salts alone was exclusively Gramineous (other plants being actually reduced in amount), it was also almost exclusively composed of the leafy herbage of the less grossly growing grasses.

Under the influence of ammonia-salts alone the produce did not contain a quarter of 1 per cent. of Leguminous herbage.

The proportion of total Miscellaneous plants, and the number of species, were reduced by the use of ammonia-salts alone; but some few plants were very strikingly encouraged, especially the *Rumex acetosa*, which was both abundant and luxuriant. *Carum Carui* was also very prevalent, more so than the figures would indicate; the small weight being probably due to its being ripe, and having shedded much seed before being cut. *Achillaea millefolium* was also a very prominent plant; and *Luzula campestris* was more so than on most of the manured plots.

Effects of Nitrate of Soda alone.

The effects of nitrate of soda alone, though in many respects similar to those of ammonia-salts alone, show some peculiarities. The proportion of the total herbage referable to the five predominating Gramineous genera is unusually small; whilst a plant occurring in the produce without manure in very small quantity, and in less amount still in that by mineral manure alone, or ammonia-salts alone, comes here into very great prominence. This grass, *Alopecurus pratensis* (fox-tail grass), a good pasture plant, but not a good element in hay, contributed 19.7 per cent. to the produce where the smaller amount of nitrate of soda was used alone, and nearly 7 per cent. where the larger amount was employed; though, in only one other case, excepting in the produce without manure, did it exceed 2 per cent. This grass was, in fact, quite characteristic of the nitrated plots. Otherwise, there was a pretty equal distribution of the grasses prevailing on the plots hitherto considered; though, as with ammonia-salts without mineral manure, there was here a great tendency to development of foliage from the base, rather than to the growth of stem and stem-leaves.

Nitrate of soda alone, like ammonia-salts alone, very much discouraged the Leguminous herbage. *Lathyrus* and *Lotus* were almost totally excluded; and *Trifolium* only contributed about a quarter of 1 per cent. of the produce.

Unlike ammonia-salts alone, the nitrate of soda seemed to encourage the *Plantago lanceolata*; and under its influence *Centaurea nigra* and *Taraxacum Dens-leonis*, though in small amount, were somewhat more prominent than usual. But next to *Plantago lanceolata*, *Rumex acetosa*; *Achillæa millefolium*, *Ranunculus (acris and bulbosus)*, and *Carum Carui* were the most abundant of the Miscellaneous plants, though none of them were very luxuriant. The total amount of Miscellaneous herbage was comparatively large, but resulted from the great frequency of some few species, rather than from either great variety, or great luxuriance of any particular plants.

Effects of Farm-Yard Manure alone.

Farmyard dung alone, the manure upon which dependence must to a great extent be placed for grass-land devoted to the production of hay, gave a produce containing 79 per cent. of total Gramineous herbage, but a comparatively small proportion (51.9 per cent.) referable to the five predominating genera; and this was the case notwithstanding that one grass, *Poa trivialis*, which was not at all prominent on any of the plots already considered, contributed 27½ per cent. of the total herbage as sampled. The notes taken on the ground agree with the figures in showing this plant to have been very prominent; and, as will presently be seen, it also occurred in very predominating amount on the plot manured with farmyard-manure and ammonia-salts. So far farmyard-manure improves the character as well as increases the amount of the Gramineous herbage; but it also brings into greater prominence than any of the other manures *Bromus mollis*, which is reputed to be a very bad food-grass. It, at the same time, encourages the free-growing, productive, and, upon the whole, good but somewhat coarse grass *Dactylis glomerata* more than any of the manures yielding the smaller crops. The three grasses *Poa trivialis*, *Bromus mollis*, and *Dactylis glomerata*, which are thus seen to be increased in their development by farmyard-manure, are so at the cost chiefly of *Festuca duriuscula* and *F. pratensis*, but partly of *Avena pubescens* and *Agrostis vulgaris*, and in a less degree of some other grasses.

The produce by farmyard-manure contained a much less amount and proportion of Leguminous herbage than that without manure; both *Trifolium* and *Lathyrus* being much reduced, and *Lotus* excluded, at any rate from the mown sample. This result is probably due more to the increased luxuriance of the grasses and certain Miscellaneous plants, by which the Leguminous ones are displaced, than to any directly injurious effect of the farmyard-manure; for the notes taken on the ground show that

although *Trifolium* and *Lathyrus* were less frequent on the farmyard-manure than on the unmanured plot, they were on the other hand more luxuriant.

The Miscellaneous or weedy plant most prominently developed by farmyard-manure was the *Rumex acetosa*, or sorrel dock, which amounted to rather more than 10 per cent. of the sample examined; though, from the notes taken on the ground, it is concluded that the sample perhaps included a somewhat undue proportion. According to the notes, *Carum Carui* was by far the most frequently occurring weed. *Ranunculus* (*acris* and *bulbosus*), and *Achillæa millefolium* were also each very frequent; and *Plantago lanceolata* was more so than in most of the crops of equal bulk. Besides those mentioned, scarcely any other weedy plants occurred; there being a large total percentage of Miscellaneous herbage, but referable to comparatively few species, and it was the frequency rather than the luxuriance of these that contributed to the large amount.

Effects of Farmyard-manure and Ammonia-Salts.

As already alluded to, the combination of farmyard-manure and ammonia-salts, like farmyard-manure alone, very strikingly developed the *Poa trivialis*, and to a considerable extent the *Bromus mollis* also. The chief distinction is, that the ammonia-salts used in conjunction with a manure supplying a large amount of mineral matter, strikingly increases the growth of the *Dactylis glomerata*, apparently at the expense of the Miscellaneous herbage, of which there were but very few species, and but a small amount, whilst the proportion of total Gramineous herbage was considerably increased. In other respects, the produce was very similar in its Gramineous components to that by farmyard-manure alone; there being, in the two cases, besides the grasses which have been specially noticed, pretty equal proportions of most of those occurring on the unmanured plot. *Holcus lanatus* was, however, rather more plentiful and luxuriant where the ammonia-salts were used.

Under the influence of ammonia-salts in conjunction with farmyard-manure all the elements of Leguminous herbage were almost as completely excluded as when ammonia-salts were used alone.

The number of species of Miscellaneous plants was unusually small under the conditions of manuring now in question; and the proportion in the produce of such herbage was also small. As in the case of farmyard-manure alone, *Rumex acetosa* was the most prominent weed. Judging from the notes and figures together, *Carum* was probably next in order of prevalence; and after it

came *Ranunculus* (acris and bulbosus), and *Achillæa millefolium*. But none of the Miscellaneous plants enumerated were so abundant here as under the influence of farmyard-manure alone; still, the amounts recorded in the Tables are attributable rather to their frequency than to great luxuriance.

Effects of Ammonia-Salts and Superphosphate of Lime.

Ammonia-salts in conjunction with superphosphate of lime, gave considerably more produce, a larger proportion of Gramineous herbage, and a larger proportion referable to the five predominating Gramineous genera than superphosphate of lime alone: the proportion of the latter being increased from 51 to 56½ per cent. of the total produce. The proportions of *Poa trivialis* and *Lolium perenne* are not much affected by the addition of the ammonia-salts; but those of *Festuca duriuscula*, *Avena pubescens*, and *A. flavescens* are considerably reduced; whilst the inferior grasses, *Agrostis vulgaris* and *Holcus lanatus* (especially the former), are brought into very considerable prominence. Although, therefore, the amount of produce was much increased by the addition of the ammonia-salts, the character of the Gramineous plants developed was somewhat inferior. *Dactylis glomerata* was not encouraged by the combination in question.

As in other cases where nitrogenous manures were freely employed, Leguminous herbage of all kinds was almost excluded.

Of Miscellaneous herbage—as under somewhat similar conditions in other cases—*Rumex acetosa* was by far the most prominent element, being both very abundant and very luxuriant. *Carum Carui* was likewise both abundant and luxuriant, but had shedded a good deal of its seed; *Ranunculus acris* and *R. bulbosus* were frequent rather than luxuriant; *Achillæa millefolium* occurred in notable quantity; other Miscellaneous species were somewhat few in number and insignificant in amount.

Effects of Nitrate of Soda and mixed Mineral Manure.

By nitrate of soda and mixed mineral manure together both the amount of produce and the proportion of it referable to the few predominating Gramineous species were greater than by either nitrate of soda alone or mixed mineral manure alone. Where the smaller amount of nitrate of soda was used with the mixed mineral manure, *Avena flavescens*, *Holcus lanatus*, and *Poa trivialis* were the predominating grasses; and, according to the figures, *Festuca duriuscula* and *Agrostis vulgaris* were also in large amount, though the notes taken on the ground did not lead

to the conclusion that they were predominating. All these grasses occurred in larger amount than where the nitrate of soda was used alone. But the most remarkable effect of the addition of the mixed mineral manure was the almost entire exclusion of the *Alopecurus pratensis*, which had flourished in such an extraordinary degree under the influence of the nitrate of soda alone, and the great development in its stead of the *Avena flavescens*, which under the latter condition had occurred in very insignificant amount. With twice the amount of nitrate of soda and the same mixed mineral manure, the distribution of Gramineous species was again very strikingly but very differently affected. *Poa trivialis* was now the predominating species; and *Dactylis glomerata*, *Lolium perenne*, and *Bromus mollis* were also in considerable quantity; *Holcus lanatus* coming next in order. Here again *Alopecurus pratensis*—the characteristic plant with nitrate of soda alone—was almost excluded; whilst *Festuca duriuscula* was reduced to a very insignificant amount, and *Avena flavescens*—so luxuriant with the smaller amount of nitrate and mineral manure—was here by no means prevalent. With regard to the great prominence of *Poa trivialis* and *Bromus mollis* on the plot now under consideration, it is, however, worthy of remark that it adjoined Plot 17, manured with farmyard-manure and ammonia-salts, where these two grasses were the characteristic plants. It would seem probable, therefore, that the result was, at any rate partly, due to seeding from the farmyard-manure plots, and hence so far accidental.

Of Leguminous plants, there was a somewhat larger proportion than by nitrate of soda alone, or by ammonia-salts either alone or in combination with the mixed mineral manure, though much less, especially of *Trifolium*, where the larger than where the smaller amount of nitrate of soda (with the mineral manure) was used, and in both cases very much less than without manure. The *Lathyrus* was more frequent than the *Lotus*: the latter, indeed, was all but wanting.

The amount and character of development of the Miscellaneous herbage differed very greatly on the two plots with nitrate of soda and mineral manure, both the proportion and the luxuriance being generally much greater with the smaller amount of nitrate. With the smaller amount of nitrate, *Rumex acetosa*, *Ranunculus (acris and bulbosus)*, *Carum Carui*, and *Achillæa millefolium* were all both frequent and luxuriant, and *Plantago lanceolata* was somewhat so. With the larger amount of nitrate, *Rumex acetosa* was by far the most frequent and abundant weed; neither *Achillæa millefolium* nor *Plantago lanceolata* was at all prevalent; whilst *Carum Carui* and *Ranunculus (acris and bulbosus)*, though somewhat frequent, were not luxuriant; and other weeds

were small both in number and amount. The general result is, that with the larger amount of nitrate and the mixed mineral manure—as with the corresponding amount of ammonia-salts and mixed mineral manure—both the number of species and the total amount of Miscellaneous plants were comparatively small.

Effects of Ammonia-Salts and mixed Mineral Manure.

There remain to be noticed, the distribution and predominance of species, on Plots 10, 11, 12a, 12b, 13a, and 13b, on which both ammonia-salts and mixed mineral manure were employed, and on which by far the largest crops were obtained.

Excepting in the case of Plot 11, where in 1862 potass was excluded from the mineral manure, the produce contained from 89½ to 95 per cent. of Gramineous herbage; and the five predominating grasses ranged from about 61½ to about 68½ per cent. of the total produce. In four out of the six cases the free-growing and bulky *Dactylis glomerata* was the predominating grass, contributing in one case 31 per cent., and in the case of the smallest amount of it nearly 22 per cent. of the total produce. In the two other cases, the *Avena pubescens* and *A. flavescens* in about equal proportions predominated, amounting together to from 18 to 19 per cent. In two out of the four cases where *Dactylis* predominated (Plots 13a and 13b) a very excessive amount of ammonia-salts was employed; and in the one case the mineral manure contained silicates, when a considerably larger amount of *Agrostis* was found in the produce, but whether the result were really due to the supply of the silicates may be a question. In fact, it was in dealing with the very heavy and luxuriant crops that the difficulty of fairly sampling was the greatest; and we would, therefore, especially in such cases, rest our conclusions much more upon the general than upon the exact indications of the figures. Although *Agrostis* and *Holcus*, two bad elements, occurred in considerable quantity in the bulky produce of all the highly-manured plots, it is satisfactory to observe that the free-growing and useful *Dactylis*, the sweet and much-relished *Avena pubescens* and *A. flavescens*, the useful *Poa trivialis*, and the free-growing and nutritive *Lolium* were all prominent components in these luxuriant crops. Of other grasses, *Festuca duriuscula* or *F. pratensis* came next in order of prevalence, the rest occurring for the most part in very insignificant proportions. Of Leguminous plants these heavy crops in some cases contained scarcely a trace, and in others only very insignificant amounts.

Of Miscellaneous herbage, *Rumex acetosa*, as usual with full

manuring of any kind, is by far the most predominating plant; Carum Carui and Achillæa millefolium coming next in order. All others, Ranunculus and Plantago included, occurred in very small amounts; and the total quantity of Miscellaneous herbage, which was small, was attributable chiefly to the luxuriance of the Rumex and the Carum, and the frequency of the Achillæa millefolium.

III.—*The tendency to the Development of leafy or stemmy Produce, and the Order of Ripeness.*

As already explained, in the separations of 1858, the results of which were recorded in our former Report, the Gramineous herbage was classified into "Stems bearing flower or seed," which could be referred to particular species, and into "Detached leaf and indeterminate stems;" and hence the figures pretty directly indicated the relative tendency to the production of stem and seed, or of leaf. But since in the recent separations all the detached leafy matter that could be identified is included, with the stemmy portion, under the head of "Determined species"—the remainder only being put down as "Undetermined stem and leaf," or "Shedded flowers and seeds, &c."—the numerical results of the present inquiry do not serve to illustrate the subject of the tendency to the development of leafy or stemmy produce. The figures in the column in Table II. showing the amounts remaining as "Undetermined stem and leaf" do indeed indicate, where the amount is large, that the separation and identification were unusually difficult, and so far generally that the produce was leafy and ill-defined rather than stemmy and matured; but in the few remarks we have to make on the point in question, as well as on that of the relative ripeness, we shall rely on careful observations made on the ground just before and at the time of cutting, in which ten conditions or orders of ripeness of the produce (of the 20 plots) were noted.

The unmanured plots presented a very thin crop of stem, with a full and uniform development of leaves, which were, however, very short, affording upon the whole a pretty even and close, but meagre bottom herbage, which was green and late at the time of cutting, its order of ripeness being No. 8. Leguminous and Miscellaneous plants were numerous, but mostly of stunted growth.

Superphosphate of lime alone gave a crop very much like the unmanured one as to general relation of leaf and stem, &c., but it was rather more luxuriant, and showed more tendency to the production of fine leaf, chiefly belonging to the smaller and later

grasses; it contained much less Leguminous herbage, nearly the same proportion of Miscellaneous plants, and was somewhat more matured at the time of cutting, its order of ripeness being No. 6.

Mixed mineral manures alone gave a very equally maturing and generally ripe crop, but with only a small proportion of the more grossly growing grasses; the finer ones, however, mostly flowering or seeding. Leguminous plants were very numerous and luxuriant, but few of the Miscellaneous ones were so. Order of ripeness No. 2.

Ammonia-salts alone gave a very green and unripe crop, the order of ripeness being No. 10. There was a dense bottom herbage, with the foliage coming chiefly from the root, and very little flowering tendency. Upon the whole the grasses, which were for the most part of the smaller kinds, seemed but partially developed, apparently exhausted, and not likely to mature. *Lolium perenne* showed the most tendency to form stem and seed, but was frequently monstrous or dying.

Nitrate of soda alone gave a crop which at the time of cutting was very late, dark green, and still growing, without the look of exhaustion exhibited by the herbage grown by ammonia-salts alone; it was much more leafy than stemmy, forming a dense mass of grassy produce, for the most part referable to the smaller-leaved species; and, as the amount of undetermined stem and leaf will show, the separation and identification of its components were unusually difficult. The order of ripeness was No. 9.

Farmyard-manure alone yielded a produce which was, upon the whole, comparatively ripe, standing 4th in this respect, but it was very unequally so. All the grasses gave a fair proportion of stem, and they were also generally plentiful in both base and stem-leaves. *Poa trivialis* and *Bromus mollis* were the predominating grasses, but there was a fair proportion of most of the others found on the unmanured land, the grosser species being, however, somewhat restricted in development.

Farmyard-manure and ammonia-salts, like farmyard-manure alone, gave a very unequally ripe crop, which also in order of ripeness was No. 4. Its characteristics were great luxuriance, a fair proportion of both stem and leaf, and a considerable variety of herbage; but with *Poa trivialis*, *Dactylis glomerata*, and *Bromus mollis*, by far the most prominent species among the grasses, giving upon the whole a strong and thick-bottomed, but rather rough crop.

With superphosphate of lime and ammonia-salts the crop was much more backward than with superphosphate of lime alone, coming 10th instead of 6th in order of ripeness. There was,

relatively, much less development of stem and much more of leaf, forming a strong and luxuriant bottom-grass, of a dark-green colour.

The mixed mineral manure and nitrate of soda gave crops which were very much riper, especially where the double amount of nitrate was used, than those by nitrate of soda alone; the order of ripeness was with the smaller amount of nitrate (and minerals), No. 5, and with the larger amount, No. 1; the crops with nitrate alone standing 9th, and those with the mixed mineral manure alone 2nd. There was, however, a great tendency to the production of leaf, the stems being somewhat thinly distributed.

The mixed mineral manure in conjunction with ammonia-salts, as with nitrates, greatly enhanced the production of stem and the ripening tendency. The crops grown by this combination—which were the heaviest in the series—were very luxuriant, and still vigorously growing at the time of cutting, the grosser species of grass predominating. There was a very full development of both stem and leaf; the foliage, however, coming in larger proportion than usual from the stem. With the smaller amount of ammonia-salts the crops were 4th in order of ripeness; but with the larger amount they were only 7th, being later, greener, and more vigorously growing, and showing a greater abundance and luxuriance of *Dactylis glomerata*.

In connexion with the results brought out in this inquiry into the action of special manures on the mixed herbage of grass-land, it will be interesting, at the present time, when the subject of the utilisation of *town sewage* is so much discussed, to call attention to the prominent characters of the herbage developed when it is applied to permanent meadow land.

In some experiments conducted during the last two years by the Royal Sewage Commission, and still in progress, on the application of the town sewage to grass land at Rugby, it is found that effects have resulted very similar to those recorded in this paper. The prevailing grasses on the unsewaged land were *Dactylis*, *Holcus*, *Lolium*, *Festuca*, *Agrostis*, *Poa*, and *Avena*; a number of others occurring in smaller proportion. Of the sewaged produce, by far the largest proportion consists of *Dactylis*, *Holcus*, and *Lolium*; whilst *Festuca*, *Agrostis*, *Avena*, *Poa*, and other grasses, are far less prominent than in the unmanured produce. Under the influence of sewage too, the Leguminous herbage is found to be almost excluded; and the Miscellaneous weedy plants are very much reduced in variety, though some few are very much increased in luxuriance, among which *Rumex*, *Ranunculus repens*, and sometimes *Taraxacum*, are the most prominent.

In the well-known Edinburgh sewaged meadows again, the herbage is for the most part of a very simple character. Of the grasses, the most prominent, and the most valued for its yield of green food, is the *Poa trivialis*; next in prevalence, and perhaps in general estimation also, is the *Triticum repens*, or couch grass; and after these, frequently occur *Lolium perenne* and *Dactylis glomerata*. Of weedy plants, the *Ranunculus* seems to be the most prevalent and luxuriant, especially where the drainage is imperfect. It should be observed, however, that many of the Edinburgh meadows have been laid down specially with a view to sewage irrigation; though, where old permanent meadows have been brought under treatment, or a considerable mixture of grasses has been sown in laying down for irrigation, it is still found, after a few years, that the great bulk of the herbage is composed of but a few of the freer growing grasses.

It will be readily understood, however, that the value of the produce of ordinary permanent meadow land, and of a sewage-irrigated meadow, depends upon very different qualities, and that a character of growth which may be a disadvantage in the one case, may be advantageous in the other.

The produce of the ordinary meadow, if designed for hay, is allowed to approach nearly to maturity before being cut, and over luxuriance of growth, tending to the great predominance of a few very free growing grasses, is likely to be accompanied by an undue development of woody stem, giving a hard, coarse, and comparatively indigestible and innutritious food. There is, in fact, an obvious limit beyond which it is not advantageous to go in forcing the hay crop by means of artificial manures; for, beyond a certain point, which the intelligent practical farmer will not be slow in discerning, not only is less increase of produce obtained for a given amount of manure employed, but the increased quantity is gained at too great a sacrifice of quality.

It is quite otherwise with the sewage-irrigated meadow, the produce of which is to be cut green. Although it may happen that only the very free growing (and under some circumstances objectionable) grasses may be encouraged, yet they are mown in a young and succulent condition, before their objectionable qualities have been developed, and the faster they grow the oftener they are cut. Hence, whilst their great luxuriance is only an advantage, their tendency to yield a hard later growth is not against them.

The most prominent results of the whole inquiry may be briefly enumerated as follows:—

1. So far as the general distribution of Gramineaceous, Legu-

minous, and weedy herbage, and the tendency to the production of leafy or stemmy produce, and to early or retarded ripening are concerned, the characters of the produce of the seventh season of the experiments (1862) are, in the main, similar to those before recorded of the produce of the third season, 1858; but there is considerable change in the relative predominance of certain species on particular plots. *Dactylis glomerata*, *Festuca duriuscula* or *F. pratensis*, *Avena pubescens* or *A. flavescens*, *Poa trivialis* or *P. pratensis*, and *Alopecurus pratensis*, have, respectively, become much more prevalent on one or more of the plots, according to the description of manure employed.

2. The *unmanured* produce consisted of 74 per cent. Graminaceous, 7 per cent. Leguminous, and 19 per cent. weedy herbage. It showed great variety, and comparatively little predominance of individual species. *Festuca duriuscula* and *F. pratensis*, and *Avena pubescens* and *A. flavescens*, were the most prominent; whilst the freer growing grasses were in smaller amount, and a number of others in less proportion still. The crop was even, but very short, and with little development of stem: and it was green, and comparatively late, at the time of cutting.

3. *Mixed mineral manures alone* gave comparatively little increase of Graminaceous herbage, and reduced the proportion in the produce, both of it and the weedy herbage; but they greatly increased both the amount per acre, and the proportion, of the Leguminous plants, *Trifolium*, *Lathyrus*, and *Lotus*. The description of the Graminaceous herbage was not very much altered from that of the unmanured land; there was no striking predominance of individual species, but, compared with the produce by more productive manures, a pretty even mixture of most of the grasses occurring without manure, and those which did show any prominence were chiefly of the smaller and less free-growing kinds. The tendency to form stem and seed, and to early ripeness, was much greater than without manure.

4. *Ammonia-salts alone* considerably increased both the amount and proportion of the Graminaceous herbage, almost excluded Leguminous plants, and generally reduced the number and amount of Miscellaneous or weedy species, but much increased the luxuriance of some, particularly *Rumex acetosa*, *Carum Carui*, and *Achillæa millefolium*. The relation to one another of the Graminaceous species, as to amount, was much the same as without manure, excepting that *Festuca duriuscula* and *Agrostis vulgaris* were brought into much greater prominence. The increased growth was characteristically that of root or base-leaves, and there was very little tendency to form stem or to ripen.

5. *Nitrate of soda alone*, like ammonia-salts alone, considerably increased the produce of Gramineous herbage, and tended chiefly to the production of root-foliage. The nitrate, however, strikingly brought into prominence the *Alopecurus pratensis*, at the expense, compared with the produce by ammonia-salts, chiefly of *Agrostis vulgaris*, and partly of *Festuca duriuscula*. Otherwise, the distribution of species was not very materially altered, the more luxuriantly-growing grasses not being much developed. The crop was much more leafy than stemmy, very dark green, and late; contained very little Leguminous herbage, though rather more than the produce by ammonia-salts alone; and the weedy plants were luxuriant rather than numerous—*Plantago lanceolata*, *Centaurea nigra*, *Rumex acetosa*, *Achillæa millefolium*, *Ranunculus*, and *Taraxacum*, all being more or less encouraged.

6. *The combinations of nitrogenous manure* (ammonia-salts or nitrates) and mixed mineral manures, gave by far the largest crops, the largest proportion of Gramineous herbage, the largest proportion referable to a few species, scarcely a trace of Leguminous plants, and a small proportion both in number and amount of Miscellaneous or weedy ones. The produce was very luxuriant, with a great development of stem and stem leaves, and a much greater tendency to ripen than when the ammonia-salts or nitrates were used without the mineral manure. The predominating grasses were the most bulky and free-growing ones; *Dactylis glomerata*, and *Poa trivialis*, being very prominent; and *Avena pubescens* or *A. flavescens*, *Agrostis vulgaris*, *Lolium perenne*, and *Holcus lanatus*, somewhat so. *Festuca duriuscula*, *F. pratensis*, *Arrhenatherum avenaceum*, *Alopecurus pratensis*, *Bromus mollis*, and others, were almost excluded.

7. *Farmyard-manure* considerably increased the growth of the grasses, and of some few weeds, particularly *Rumex*, *Ranunculus*, *Carum*, and *Achillæa*, and reduced that of clover and allied plants, more especially when used in combination with ammonia-salts. It greatly encouraged the growth of the good grass *Poa trivialis*, and of the bad one *Bromus mollis*; and when in conjunction with ammonia-salts the *Dactylis glomerata*. Under both conditions *Festuca duriuscula* and *F. pratensis* were nearly excluded, and *Avena flavescens*, *A. pubescens*, *Agrostis vulgaris*, *Lolium perenne*, and *Arrhenatherum avenaceum*, were very much reduced. The crops were upon the whole bulky, comparatively simple as to description of herbage, fairly luxuriant both in stem and leaf, somewhat rough and coarse, and showing a tendency to unequal ripeness.

8. *Leguminous herbage* was almost entirely excluded whenever nitrogenous manures were used in any quantity, whether in the form of ammonia-salts or nitrates, alone or in combination

with mineral manures; but it was somewhat less so with the nitrate than with the ammonia-salts. Mineral manure alone, containing both potass and phosphoric acid, greatly increased the growth of the Leguminous plants perennial red clover and meadow vetchling. Farmyard-manure like artificial nitrogenous manures, also, but in a less degree, much diminished the proportion of the Leguminous herbage.

9. Every description of manure diminished the number of species, and the frequency of occurrence, of the *Miscellaneous* or *weedy herbage*; mineral manures alone less so than any other; nitrogenous ones, especially in combination with mineral constituents, did so very strikingly, but they at the same time greatly increased the luxuriance of a few species, especially *Rumex acetosa*, and frequently *Carum Carui* and *Achillæa millefolium*. *Plantago* and *Ranunculus* were generally discouraged by active manures, excepting farmyard-manure and nitrate of soda. The nitrate also favoured *Centaurea nigra* and *Taraxacum Dens-leonis*.

10. Considerable increase of produce was only obtained by means of farmyard-manure, or artificial manures containing both mineral constituents and ammonia-salts or nitrates. The crops so obtained were much more Gramineous, and consisted in much greater proportion of but a few species of plants. The grasses developed were chiefly of the more bulky and freer growing kinds, and the produce was generally very stemmy—being the more so, and the coarser, the more excessive the manuring.

11. Meadow-land mown for hay should not be manured exclusively with artificial manures, but should receive a dressing of well-rotted farmyard dung every four or five years.

12. Sewage irrigation, like active manures applied to meadow-land in the ordinary way, has also a tendency to develop chiefly the Gramineous herbage, excluding the Leguminous, and to a great extent the *Miscellaneous* or *weedy plants*. It also, at the expense of the rest, encourages a few free-growing grasses, among which, according to locality and other circumstances, *Poa trivialis*, *Triticum repens*, *Dactylis glomerata*, *Holcus lanatus*, and *Lolium perenne* have been observed to be very prominent. The result is an almost exclusively Gramineous and very simple herbage. But, as the produce of sewage-irrigated meadows is generally cut in a very young and succulent condition, the tendency which the great luxuriance of a few very free-growing grasses has to give a coarse and stemmy later growth is less objectionable than in the case of meadows left for hay.

X.—Co-operative Farms at Assington, Suffolk.

TO THE EDITOR OF THE JOURNAL OF THE ROYAL AGRICULTURAL SOCIETY.

DEAR SIR,

Tunbridge Wells, January 10, 1863.

WILL you allow me a space in your valuable Journal for a subject most interesting to the cultivators, as well as to the lords of the soil? We must all admit that, owing to the depressed state of the labour-market, the former are insufficiently remunerated; the consequence is that poaching and petty thefts are the crying evils of the age. About thirty-three years ago I formed a plan to raise the labourer in *his* class, without taking him *out* of it, by giving him a stake in the country, and thus rendering him a responsible man, not only to his God, but to his neighbours; I do not add, to be *independent* of his fellow-creatures, for such a principle I detest. Dependence upon God in the first instance, and secondly upon our neighbour, is the mainspring of society, each forming a link in the human chain. I am for progressing with the times; I like large farms and extended fields; they save the landlord many buildings, they give full scope to machinery, and they meet the requirements of the march of intellect; still there must be small, isolated, off-hand farms, and such are generally ill-cultivated or neglected: it is to these I wish to call your attention. One of this sort, 100 acres more or less, becoming vacant in 1839, I called together 20 of the better class of labourers in the parish and offered them the farm with the loan of the necessary capital (without interest) if they would undertake to cultivate it conformably to my regulations, each man paying down 2*l.* as a guarantee. They gladly accepted my proposal, and in the course of 10 years or so the capital, 400*l.*, was paid back, and they were in complete possession as tenants of a well-cultivated and well-stocked farm. I was so fully satisfied with this success, that, upon another isolated farm of 150 acres becoming vacant in 1852, I put in 30 men upon the same terms, and of the capital then advanced only 50*l.* remains unpaid—a charge which they hope to liquidate during the present year. Simple and inexpensive as my plan is, after so long an experience, I can say confidently that it has not one drawback: the labourer himself has now something to lose; his sympathy is drawn out towards his master, for, in his calamities, he can feel as one who might have been in the same predicament; physically, he is better fed, and consequently he can do greater justice to his employer than heretofore; the farmer can also put more confidence in him, as conviction of theft would deprive him of his share in the society, which is now worth upwards of 50*l.* The landlord has also his advantages—less marauding, less poaching,

and (as in my case) 50 families not only taken off the parish rates, but interested in keeping them low as being themselves rate-payers. To give further security to this part of the scheme, each member is called on to insure in the Stoke and Melford Benefit Club for 10s. a week during sickness; 5s. a week after the age of 65, when all payments cease; and 5l. for funeral expenses. The aforesaid club was established by me in 1828 upon Government principles, and thanks to the energy and unwearied attention of the local clergy, who act as directors in their several parishes, their invested capital now amounts to upwards of 23,000l. The subjoined agreement is that which was adopted by me and the members of the Assington Association; it may be altered to meet the wishes of other parties who may feel disposed to act on the hint here offered; indeed, I am aware that it is highly desirable that these rules should be placed before a person of enlarged legal knowledge and experience in such matters for revision with a view to registration.

When at Assington I attended the Michaelmas quarterly meeting of the Association, and I have been surprised at the shrewd and apposite remarks made by these uneducated labourers. As the services of only 10 or 12 workmen are required on the two farms, the remaining members serve their old masters as usual. In passing through the village you would not know that any such institution existed, unless you met a well-appointed waggon inscribed "The Assington Agricultural Co-operative Society," or "The Assington Agricultural Association."

I remain, dear Sir, yours truly,

JOHN GURDON.

THE ASSINGTON AGRICULTURAL CO-OPERATIVE SOCIETY.

"Two are better than one, because they have a good reward for their labour; for if they fall, the one will lift up his fellow: but woe to him that is alone when he falleth, for he hath not another to help him up."

"Wealth gotten by vanity shall be diminished; but he that gathereth by labour shall increase."

"Much food is in the tillage of the poor; but there is that is destroyed for want of judgment."

AGREEMENT.

I agree to let from Michaelmas, 1830, for my life, to the under-mentioned persons, forming themselves into a *Co-operative Society*, a farm, containing 114 acres more or less, free of Great Tithes, for the annual rent of 168l., upon the following conditions:—That the Society do not diminish their number of 20 members; that the land be farmed upon the four-course husbandry; that they conform to

the rules of the Society and pay their rent regularly; that they keep the premises in good repair, the landlord finding all rough materials; that they do 1 day's carting with 4 horses and 2 men; that they insure the premises for 500*l.* against fire, and that every 12 years the farm be revalued.

(Signed)

JOHN GURDON.

Assington Hall, March 25, 1830.

Names of Members.

T. BUTCHER.	H. CRISELS.	H. HARPER.
W. CRISELS.	W. CLARK.	T. HYWARD.
W. HAZEL.	J. CRISELS.	J. CRISELS.
J. DEAL.	WIDOW GOSLIN.	J. DEAL.
W. DEAL, Sen.	WIDOW BUTCHER.	G. FROST.
W. DEAL, Jun.	W. HARPER.	W. GRIGGS.
J. WARD.	WIDOW HARPER.	

RULES AND REGULATIONS.

1. That this Society be denominated the "Assington Agricultural Co-operative Society," and consist of 20 members, for the purpose of cultivating the aforesaid farm for their mutual benefit.

2. That a committee, consisting of three members, be appointed yearly, by ballot, at Michaelmas, for keeping the accounts and superintending the cultivation of the farm.

3. That four meetings be held at the house yearly, viz. the first Tuesday after every quarter-day, for auditing the accounts and transacting any business that may be requisite.

4. That the house be let to two members agreed upon by the Society; that they have the charge of the live stock; that one be regularly employed upon the farm; and that whatever extra labour is required be arranged by the committee.

5. That the following articles be provided by the committee for the use of the members, viz. household stores of all descriptions, home-brewed beer, milk, pork, bacon, flour, and whatever else may be considered desirable.

6. Any member convicted of fraud or any other crime to be excluded from the Society, with the forfeiture of his share;* if refusing to work when called upon, or slighting it, the committee to find a substitute, and to pay him out of the member's share of the profits.

7. Any member falling into unforeseen difficulties, may be advanced a loan upon his share to half its value at 5 per cent. interest, provided the funds will admit of it, or he may sell his share, subject to the landlord's and members' approval.

8. That the Society be answerable for no debts, except those contracted by the committee for the public advantage.

* A share so forfeited is designed to form a reserve fund to meet contingencies; the latter part of this rule is not acted upon.

9. Upon the death of a member, if his share be not disposed of by will, his widow may enjoy it during her widowhood, and at her decease or subsequent marriage the share to be vested in his eldest son living in the parish; in default of sons to be sold for the benefit of daughters or next of kin.*

10. If a new member upon the purchase of a share be unable to advance the whole amount, he must be charged 5 per cent. for such moneys in arrears, until the whole be paid to those entitled to it.

11. Vacancies to be filled up by ballot upon terms agreed upon by the members; but those only who are labourers of the parish and members of the Stoke and Melford Union Association to be eligible.

12. Any alterations to these rules, or new ones added, may be effected, if carried by vote at either of the public meetings, with the sanction of the landlord, and entered into the general minute-book.

Remarks on Mr. Gurdon's Letter.

I had much pleasure in visiting Assington, near Sudbury, in December last, that I might personally inspect the farms to which the preceding letter refers. As the days were short and I had come from some distance, I paid more particular attention to the older farm, the manager of which accompanied me in my walk. This farm consisted of one large field, varying between a hazel-loam and clay, and several smaller fields, some of which had a gravelly soil. At that season but few growing crops were to be seen, but the young wheats looked well; there was a large clump of mangold, drawn from 4 acres, some good swedes and white turnips, and very promising tares: the fallows were well done; the land was very clean. The labour of horse and man evidently was not stinted.

The swede turnips were very good; hoggetts were eating off white turnips before folding off the swedes, of which the largest had been drawn for stock in the yards. The stock of sheep was not as large as usual, because the 50 breeding ewes commonly kept on the farm, were being fattened off for a sufficient reason; hence the supply of turnips was fully adequate to the head of stock—75 hoggetts and a few ewes, and were therefore being consumed without any extra dry food, either hay, cake, or corn, which I consider bad policy. For these turnips no other artificial manure

* Rule No. 9 has been thus modified:—"Each member should make his will before two witnesses in favour of his widow; it should be sealed and deposited with the committee. The widow should enjoy the share during her widowhood; at her decease or subsequent marriage the share should be vested in the eldest son living in the parish.

"In default of sons, it is to be sold (subject to the landlord's approval) for the benefit of daughters or next of kin."

had been applied than lime and ashes from a neighbouring "malting." Some fine swedes had been thus grown, but the addition of superphosphate or bones seems to me generally desirable, particularly on a gravelly soil, as in the case before us.

Draining had been executed where it was required, but of this work I saw more evidence on the adjacent associated farm, which has a stronger soil. This work had been executed by landlord and tenant conjointly, as on other farms in the Assington estate.

The stock were in good condition. I saw two or three very smart Suffolk mares, which would throw valuable foals, and 3 other horses; 5 milch cows; 4 good beasts, half-bred between the polled Suffolk and short-horn, fattening chiefly on swedes; 4 Highland beasts; 6 sows and about 40 pigs, of a very good sort, many of which are fatted for the supply of the members.

The farm had been much improved by the liberal dressings of lime, which is bought 5 miles off at 1s. per load. A good deal of timber and other carting is done for Mr. Gurdon's woods, &c., which accounts for 6 horses being kept.

In short, though neither as much oilcake and corn or artificial manure is bought as a tenant of a light-land farm would think desirable and profitable, still the general appearance of the farm was such that a superior farmer of the smaller class would feel a pride and satisfaction in showing it, and the system of cultivation is one that would neither much advance nor diminish its fertility.

The rent charged for the farm, 29s. 3d. per acre, appeared to me fairly to represent the probable value of the land at the time of hiring in 1829, though if it were now revised it would doubtless be raised. In this respect I believe this farm stands quite on a level with the other farms in the parish.

With respect to the management, as much control and responsibility devolves upon the Manager as generally on a gentleman's farm-bailiff. Although the committee meet every fortnight to make up the accounts and give directions, they wisely refrain, for the most part, from interfering with questions of labour, beyond authorising such a supply as the Manager thinks necessary.

The labourers receive wages in the usual manner; and at the time of my visit, of the 5 men and 1 boy here employed, only one besides the manager was a member of the association, and he had no voice in the management or choice of work. If any member happened to be out of work, the Manager would probably find him a job; but they are not generally of that stamp of men who are cast adrift when work is slack.

Thus, if the rules contemplate or admit of any partnership in labour, the good sense of the community has thus far left them in abeyance; wages are paid for work done, and a single officer

has full power to direct what shall be done, and see that it is properly executed.

One tenement was occupied by the widow of the member who first occupied it.

The general routine of buying and selling is also commonly left to the Manager, although for an important purchase of stock he would probably confer with a committee-man of judgment and experience in that department; and to that end a good judge of stock as well as a good accountant would generally act on the committee. The post of manager is, therefore, one of much responsibility and considerable anxiety, because losses are a serious matter to such employers as he acts for. The stability of the enterprise must depend on the confidence reposed in this officer, and the moderation of the committee and association in not declaring or claiming an extra dividend after an unusually prosperous season, but keeping some funds in reserve against a "rainy day." For his services the manager only receives 1s. per week above the general wages; he does not even live rent free: his chief benefit being that his wife has 10l. a year for performing the ordinary duties of a farm housewife.

There can be no doubt that many gentlemen would put a higher value on the services of so trustworthy a servant; on the other hand, it might not be easy to replace him if he were tempted to change his position. This difficulty would not arise from want of good raw material, but from the time required to mould it into form. In no walk of life does the old English stamp of character stand out more prominently than in the intelligent, considerate, upright manliness of the picked labourer who often acts as bailiff for a large farmer, at a rate of pay which bears but a small proportion to the trust reposed in him. Such men are not scarce, but they have no experience in buying and selling, and therefore are not fit to act independently as bailiffs. Should such associations as this receive a wider development, and the merits of their successful managers be recognised, it may become requisite to have constantly an assistant manager, who may be capable of carrying on the system if the senior manager should be removed to a better appointment.

In the regulation of the work and wages this farm, therefore, wisely avoids peculiarity.

Of the direct profits made and dividends received I am not qualified to speak, not having been permitted to inspect their books of accounts. It is acknowledged that the profits are very good, but Mr. Gurdon himself is ignorant of their amount. If there were room for complaint or dissatisfaction, this reserve would not be maintained.

One of the indirect advantages which the rules of the society

appear to contemplate is that its members should be empowered to buy the chief necessities of life at a less disadvantage than generally falls to the poor man's lot. This intention is carried out with regard to flour, pork, milk, coals, and wood for fuel. The association contracts with a miller for the supply of flour to its members at a rate of 3s. 4d. in the sack below that charged to the general public. This allowance is but small compared with the exorbitant extent to which the price of many commodities is raised to the consumer as they pass through various hands; but even this amount is a consideration to a poor man, and represents a considerable percentage. Pigs are fatted on the farm, and a certain weight sent to each member—almost as a dividend in kind. Five good milch cows are kept, and the new milk is sold at 2d. per quart, skim at $\frac{1}{2}$ d. Since the supply is considerable, and many members live too far off to avail themselves of it, others besides the members profit by this retail trade, which but few farmers' wives would be troubled with. Where there is illness and a young sickly family, can the worth of such a supply be over-estimated? The poor man has too commonly lost this comfort, if not necessary, of life in consequence of the disappearance of our commons and small holdings as our agriculture has advanced. A stock of coals is also purchased economically in summer, and carted in for each member free of cost to the extent of 1 ton. Wood bought for fuel in this parish (which retains 300 acres of woods) is also carted gratuitously.

The wholesale purchase of groceries and the brewing of beer for the members, have been under consideration, but have not been put into operation. Since the charges and profits of the retailer have too often failed to adapt themselves to the modern facilities of transfer which railroads and other commercial and social improvements have introduced, society has no reason to look with jealousy on such attempts, especially a class of society which is so much victimized by intermediate agents as the farmers.

Since, then, this association (while exhibiting good, but not advanced farming) does not revolutionize labour, and does not much affect trade, it remains to be seen wherein its chief influence and merit consist.

The benefit done to the labourer seems to consist mainly in this,—that it suggests to the prudent young workman a good mode of investment commensurate with his means, and sufficiently attractive to induce him to forego the lesser enjoyments of the moment, which swallow up savings, if they do not lead to vice. It is attractive because he can understand, appreciate, and in some degree control the adventure, which in this respect contrasts most favourably with the speculations in which many richer men

risk their fortunes, with little ground to trust the agents they employ, and no knowledge of the field which they are working. It offers a trade profit, instead of the modicum of interest given by the savings' bank, and still does not remove the workman from his field of labour. Moreover, its influence is not felt by the members only, but by all who look forward to availing themselves of a vacancy or an extension of the system.

For the parish generally its influence cannot but be beneficial, especially in reference to the rates, as Mr. Gurdon has pointed out. Four of the shares in the older farm are now held by widows, who, as well as the other shareholders, refrain from seeking parish relief. The proceeds of their share must in some instances be their sole maintenance. This consideration alone speaks well for the profits of an undertaking consisting of 20 shares now valued at 50*l.* each (or 1000*l.* in all), which commenced with a capital of only 440*l.*

The position of the widows of members requires especial consideration: first, that the reversion of the share may be assured to them for life, or, if this cannot be made *certain*, that they may be put in a *fair way* for succeeding to it. Secondly, since this property debars them from receiving parish relief, it is important that the shares should be sufficiently large to insure them a subsistence. This object will have to be balanced against another consideration, viz. that the share must not be so large as to represent a greater amount of capital than a prosperous labourer can command or save within a reasonable period of time.

Let us put the case of a vacancy occurring when a share is worth 50*l.* Suppose that the candidate, elected by ballot and approved by the landlord, can only pay 5*l.* down—say that their undertaking pays 10 per cent. on the average: it will then take the new member 9 years to pay up his full share at the rate of 5*l.* a year, and till he has done this he gets no dividend; if the share bore a value of 80*l.* he would have 6 more years of expectation, and yet it can hardly be calculated that a share of less than 80*l.* should afford a comfortable provision for a widow.

Mr. Gurdon informs me that a steam thrashing-machine has also been worked in connection with the association to considerable advantage. This I can well believe, for, with skilful management, the profits of such a calling are larger than those derived from farming.

In these days when strikes and other combinations antagonistic to freedom, to intelligence, and to progress are rife, for the short-sighted purpose of protecting one calling to the injury of the community at large, (and especially of the largest and poorest class, whose right to gain an entrance into a trade or craft is thwarted), any plan which assists workmen legitimately to unite

in an undertaking on which their sympathies, their experience, and their intelligence may be brought to bear—an undertaking which holds out a prospect of considerable, and, on the whole, steady profits, seems worthy of consideration and of such discussion as the leading features of the scheme naturally suggest.

P. H. FRERE.

XI.—Review of ‘*Italian Irrigation*, by R. Baird Smith, Captain of Engineers, Bengal Presidency, F.G.S.’ * By P. H. FRERE.

SUMMARY OF CONTENTS.—I. Italian Irrigation, its extent and money-value.—II. The Climate and Natural advantages of Northern Italy.—III. Its Lakes.—IV. The History of Italian Irrigation.—V. The Naviglio Grande.—VI. The cost of constructing a Canal.—VII. The Canal of Pavia.—VIII. Management of Irrigated Land.—IX. Comparative statement of expenses of cultivation.—X. The Laying-out of Water-meadows.—XI. Tenure of Land and the “Consegna” or Lease.—XII. The School of Engineers.—XIII. Springs.—XIV. The Price of Water.—XV. The Measurement of Water.—XVI. The Law, and course of Legislation.—XVII. Conclusion.

SOME years have passed since, under instructions from the Court of Directors of the East India Company, the late Colonel Baird Smith thoroughly investigated the irrigation system of Northern Italy, and made known the results in a Report, “published by authority,” which fills two volumes octavo.

The size of this work, consequent on the complete manner

* A brief notice of the leading incidents in the life of this distinguished officer may give additional interest and weight to this record of his researches and opinions. In 1841 Lieutenant Baird Smith, R.E., became connected with the Canal Department of our North-West Provinces in India. He had already won the highest reputation as an hydraulic engineer when the Sikh war gave him opportunity for doing brilliant service in the field both at Aliwal, as aide-de-camp to Sir H. Smith, and again as engineer in charge at the passage of the Chenab under Sir Colin Campbell. Illness, consequent on exposure to wet on the latter occasion, led to his return to Europe. This paved the way for his Italian investigations, which were followed up by an examination of the canals of North America. In 1854, at the special request of his predecessor, Sir Proby Cautley, he was appointed head of his old department, in which capacity, whether acting as engineer, as revenue officer, or as a magistrate, he gave universal satisfaction. In the mutiny of 1857, as chief engineer, he made out the whole plan of the successful assault on Delhi, though a wound prevented him from superintending its execution. In recognition of his services he was then made a Companion of the Order of the Bath, Brevet Lieutenant-Colonel, and Aide-de-camp to the Queen. His great merit, together with his impaired health, pointed him out for the honourable and lucrative office of Master of the Mint at Calcutta. But again, when a national exigence—the last Indian famine—arose, the public voice called for his appointment as Special Commissioner. He obeyed the call; and in successfully grappling with that great calamity, freely expended all his remaining energies. Having completed his work, he returned to Calcutta, and died at Madras on his way home to England.

in which the subject is treated, has been a bar to its coming generally into the hands of those who have only a general interest in the employment of water for agricultural purposes. Meanwhile the importance of this subject in its various aspects, with reference both to England and to India, has been more and more recognised, so that a work containing such stores of information might well be epitomised for the benefit of the public.

Any notice then of this work, however imperfect, may in some degree further the design of this publication, which appears to have had a public rather than a private aim, and if that aim pointed to India rather than to England, so intimate are now the relations between those two countries that any interest excited, any knowledge circulated at home, cannot but react favourably on the fortunes of our distant empire. In furtherance of this purpose, the author's literary representatives have most liberally placed at our disposal the blocks from which the illustrations of the work were originally executed.

In our survey of Italian irrigation let us look to its extent, and the wealth it has created; briefly trace its history; review the physical and social advantages which have contributed to these results; and lastly, let us consider how far our position differs from theirs, and whether existing differences can be removed or obviated.

I.—Extent and Money-value of the Irrigation.

The valley of the Po is the great scene of this irrigation, in which Lombardy and Piedmont play the leading parts, whilst Venetia, as constituted in 1854, had a small share from including the district of Verona.

On the banks of the Ticino, the boundary of Piedmont and Lombardy, the system appears to attain its fullest development. The supply of water is, however, drawn from the tributaries of the Po (particularly those on the left bank), not from the river itself, which would be a task attended with much difficulty, because the canals must then run parallel with the Po and intersect its feeders at right angles.

In Piedmont, according to official returns, the lower provinces—Turin, Torea, Vercelli, Novara, Mortara—contain in all 1,335,680 acres, and of this total area about one-third may be deducted as land lost to cultivation by being occupied as sites of towns, beds of rivers, lakes, wastes, &c., leaving 890,454 acres fit for culture; of these, 306,613 are actually irrigated, besides 180,000 acres scattered through the valleys of Upper Piedmont.

The provinces of Torea and Vercelli, which have an irrigable

area of 270,000 acres, are actually irrigated to the extent of 121,250 acres. The addition to the rental of land through the country due to this source of increased production may be estimated approximately at a little more than 290,000*l*.

Lombardy, together with the provinces of *Brescia*, *Mantua*, and part of *Verona*, contains a total area of $6\frac{1}{2}$ millions of acres; of these, 1,061,292 acres are under irrigation in summer, and 12,837 form *marcite*, special winter water-meadows; the plain, therefore, as a whole, is irrigated to the extent of about one-sixth of its total, and about one-fifth of its productive area. "There is a progressive decrease in the ratio of irrigation to area as we proceed from west to east. Between the *Ticino* and the *Adda* irrigation is applied over nearly nine-tenths of the surface; between the *Adda* and *Oglio* over about two-tenths; between the *Oglio* and the *Adige* over not more than one-seventh or one-eighth."

The great Government canals are 133 miles long; there are 353 branch canals, which, at an assumed average of 10 miles, amount to 3530 miles. To the eastward of the *Adda* there are some 700 or 800 miles of canals, many of which are private property. Even to approximate to the length of the minute arteries of the system is quite impossible.

"At a very moderate estimate the increased returns from the land throughout the *Milanese* alone may be estimated at 270,000*l*.; in the other irrigated provinces at about 290,000*l*. per annum."

"Throughout the entire valley of the *Po*, including *Piedmont* and *Lombardy*, the extent of irrigation amounts to 1,547,905, or in round numbers 1,600,000, acres, being about one-sixth of its total area. The mass of water utilised, is nearly 24,000 cubic feet per second, the value of which, in capital, at 250*l*. per cubic foot, amounts to 4,000,000*l*. sterling [should not this be 6,000,000*l*.?]; and the increased rental due to its employment is, at a very moderate estimate, 830,000*l*. per annum." "To minds accustomed to the statistics of *England* these details may not seem imposing; but regarded in reference to the comparatively limited districts to which they apply, they are in truth large and important," and their history is "read on the face of the land and in the material condition of its two-and-a-half millions of inhabitants."

If we look to the income derived directly from these canals, the account will not be equally satisfactory.

In *Piedmont* the direct water-rents "may be calculated at about 25,000*l*. annually, of which fully four-fifths appertain to the State and the remainder to private parties. It must not be overlooked that this amount is far beneath the proper return for

the waters, but the numerous gratuitous grants which have been made during the lapse of five centuries have reduced greatly the income derivable from the canals."

In Lombardy the actual income of the government canals has been so reduced by sales and grants, that it often does little more than pay the current expenses. The income of private canals is not readily ascertained, but it is believed that these have not generally yielded a large *direct* profit.

Let us now take a hasty glance at the history of these works which have exercised such an influence on the fertility of the soil and the wealth of the people.

II.—*The Climate and Natural Advantages.*

Northern Italy certainly possesses great natural advantages from her climate, rainfall, and range of temperature; from the constancy of her supply of water in summer, from the manner in which the tributaries of the Po (but not that river itself) traverse her plain and intersect the line of her slope, from the generally porous nature of the soil, and from the services rendered by her splendid lakes.

Of an annual rainfall of 37 inches, about 28½ inches come within the seven months fitted for irrigation, and in that period fall in about 71 days, the others being fine and generally clear.

The mean temperature for May, June, July, and August is 72° Fahr., and 85° is the ordinary maximum in the shade; but in the sun the mean is 92°,—an amount of heat which renders a supply of water almost indispensable, but adds much to its effectiveness when procured, by raising its temperature.

The soil, in its natural condition, was often poor, passing from an arid sand to a pestilential marsh resting on clay. The Lumellina district is a case in point, which now presents a remarkable contrast to the deplorable aspect it bore before it was irrigated and thereby rendered one of the most productive and populous regions in Europe.

The main supply of water is drawn from the vast regions of the Alps, and being derived from snow is constantly furnished by the unvarying influence of the summer heat. As the more eastern rivers recede from this great storehouse, their streams become more capricious.

III.—*Lakes.*

Irrigation brings the famous Italian lakes before us in a commonplace point of view as great tanks designed to receive and filter the water dashed down by the mountain-torrents, cold and charged with sediment. Yet, in travelling through this mag-

nificent scenery, writes Colonel Baird Smith, "the perception of its exquisite beauty or feeling of its imposing grandeur will not be deadened by the utilitarian reflection that the whole great masses of mountain and lake are linked together as the most important elements of that hydraulic machinery on which the busy scene of agricultural life and progress in the rich plains below is essentially dependent."

Of the Lago Maggiore, both the area, 47,000 acres, and the maximum depth, 2624 feet, are remarkable. The Lake of Como reaches a depth of 1900 feet, and has an area of nearly 35,000 acres. The influence of floods is much moderated, though not obviated, by these large basins.

IV.—*The History of Italian Irrigation.*

Although we have some indications of the existence of works for irrigation in Roman times, such as an inscription on an aqueduct built in the time of Adrian, and "vestiges of dams attributed in a doubtful way to the emperors from Augustus down to Theodosius," these efforts appear to have been applied rather to springs and rivulets than to works on a grand scale for the diversion of large supplies from the chief rivers.

From the irruption of the barbarian hordes the same evils ensued in Northern Italy (though not to the same extent) as those which gave birth to the Pontine Marshes and the Maremma of Tuscany. "A great part of the province" (of Lombardy), writes Bruschetti, "was at this time covered with forests. Tracts now richly cultivated were then stagnant marshes or arid wastes." It was not until the dawn of a new civilisation in the 11th century that the struggle against the waters which threatened to submerge the plain was vigorously renewed. The ancient Roman ditches and defences of Milan were about this time restored, and an outlet for the waters provided by the construction of the canal called the Vettabbia.

Again, after the destruction of the city by Frederick Barbarossa in 1162, these works were reconstructed on a grander scale in 1176. Besides other works which secured to the new-built city a thorough drainage and abundant command of water, the dam of the Ponte d' Archetto was then constructed, by which the entire volume of the Nerone was directed through the city and conveyed by its sewers to the Vettabbia.

The use of water for irrigation was introduced at this same time, being due to the superior intelligence and wealth of the Cistercian monks of the neighbouring monastery of Chiaravalle. The brethren availed themselves of the neglected waters of the

Vettabbia for the irrigation of their meadows, and jealously and vigorously maintained their claims, until, finally, they secured the sanction of the government.

From this period the era of canals commences. They are the works of emancipated Italy; in many instances the memorials of special victories, the Canale della Battaglia, in particular, commemorating the overthrow of Barbarossa at Legnano.

V.—*The Naviglio Grande.*

It may be instructive briefly to trace the history of some one canal, and the Naviglio Grande, which conveys the waters of the Ticino to Milan, may serve us as a specimen. This work, which now fulfils the double purpose of navigation and irrigation, appears to have been designed for the latter object as early, if not earlier, than 1177: a charter of the Abbey of Chiaravalle, dated 1233, shows that Milan was then connected with the Ticino by a channel, part of which was navigable; in 1272 Torriano, the Guelphic chief of Milan, made it navigable throughout; in 1329 this canal played a prominent part in the discomfiture of Frederic II., its waters being diverted so as to flood his entrenched camp. "The history of the Naviglio Grande for a century after its completion is a continued record of discontents and disputes regarding the supply of water." No regulations had been at first laid down for the distribution or measurement of the water; the rules afterwards proposed were arbitrary and unsatisfactory; practically the law of the stronger prevailed, whilst the Visconti, then Lords of Milan, favoured the privileged classes, whether noble or religious, and made reckless grants to reward private services or purchase support.¹

When, however, in 1376, Jean Galeazzo Visconti made an attempt to regulate the outlets; and yet more, when, in 1446, Filippo Maria Visconti published an ordinance annulling at once all existing water rights, such a fearful tumult arose as foiled even these despotic rulers. In 1508, when Milan was in the hands of Louis XII. of France, the magistracy issued a decree, ordering that all the outlets should be reduced to a uniform height of 4 inches; that they should be cut in a single piece of stone 8 inches thick; that each outlet should be furnished with a chamber about 16 feet in length; and that the sill of the outlet should be fixed at 1.92 feet above the level of the bottom of the canal: how far these regulations were acted on is very doubtful. In the troubled times which saw the defeat of Francis I. at Pavia, and the transfer of Milan to Spain, the

science of hydraulics was making great advance, whilst the administration of justice was almost in abeyance.

In 1570, however, an Italian engineer appears on the scene, whose history deserves record as much as that of any of our own worthies.

Giacomo Soldati was employed by the magistracy of Milan to regulate the water supply, and at once perceived that the regularity of the discharge turned upon the maintenance of a constant head of pressure, "*battente stabile*."* He gave in a report which did not profess to remove all existing difficulties, but to obviate some of the most important. His proposal raised a tumult; a league was formed by encroaching proprietors; Soldati's life was threatened; rival engineers denounced his plan; but his friends were influential and firm, and within three years reforms had been effected which placed at the disposal of the State a supply of 750 cubic feet of water per second in summer, and 150 in winter. In 1576, however, a terrible plague broke out; many of Soldati's chief supporters lost their lives; the work of reform was suspended, and "to this hour remains imperfect," the usurpations of the great proprietors having in fact now become rights by prescription.

"The last view we have of Soldati is touching in the extreme. Reduced to utter poverty, deserted by his clients, persecuted by his opponents, we find him in 1578 appealing for the means of subsistence to the magistracy, representing that, as the small salary granted to him while his work was in progress had now ceased, he was in danger of starvation. The appeal was favourably received, and a moderate pension of nine lire per diem (about 5s.) was settled upon him for life.

"Such is the history of the invention and introduction of that *modulo magistrale*, which is admitted at the present day to be the best means of issuing water for irrigation which we possess."

"The narrative is not only interesting as a record of indefatigable perseverance amidst great and ultimately overwhelming difficulties, but it is most instructive. It shows clearly the danger of allowing a great system of irrigation to develop itself without well-defined regulations, of permitting interests to grow up either in ignorance or neglect, which, infringing on the rights of Government, oppose themselves afterwards with obstinacy and vigour to improvement of any kind."

The next feature of interest in the history of this canal is the flood of 1705, which carried away the whole of the headworks, changed the course of the river, and threatened to render useless

* His suggestions will be discussed at length farther on.

the whole line of the canal. Vigorous efforts were made by the magistracy to repair the disaster; and as the State had not the necessary funds—300,000 *lire*, equal to 40,000*l.*—extraordinary measures were taken to raise money; the navigation dues were raised; the outlets taxed; and all parties benefiting by other canals for irrigation were required to contribute.

In 1751 the Ticino having become the frontier line between Sardinia and Lombardy, the supply of water from it was guaranteed by treaty, and a priority of right to such quantity as might be necessary for this canal was secured to Lombardy.

The length of the Naviglio Grande, from its head at Tornavento to the new dock under the walls of Milan, is 31 miles. It runs many miles in a tortuous and deep channel before it enters the plain, and there finishes its course, running here in cuttings, and there on an embankment. The channel is irregular both in breadth and depth; the slopes are capriciously distributed, ranging in the upper section from 3.75 to 7.75 feet per mile; the mean slope is 2.84 feet per mile, "very nearly double what it ought to be in a well-constructed canal."

The most important work on this, as on most Italian canals, is the great dam which is carried obliquely across nearly the entire bed of the Ticino, leaving on the right bank only an opening of 215 feet in width. This dam has a total length of 918.47 feet; its breadth varies from 31.10 to 58.33 feet, except at one extremity where the breadth is only 7.84 feet.

The means of discharge are supplied by six grand weirs and by twelve escapes comprising 185 sluices, each from $2\frac{1}{2}$ to $2\frac{3}{4}$ feet in breadth, which are so managed by an upright iron ratchet and a simple lever, that one man can generally regulate them.

The ordinary repairs are executed under contract, extending over nine years. They amount to about 1700*l.* per annum, or nearly 55*l.* per mile.

The periodical closing of the canal is commonly effected by means of a temporary dam of fascines, piles, &c., erected at a point some little distance below the head dam, where the breadth of the channel is limited; but from time to time it is necessary to raise a dam at the head of the canal—an expensive and troublesome work.

Colonel Baird Smith naturally suggests that certain measures which would dispense with the construction of any temporary dam, would be economical on the whole, though they would involve a larger outlay in the first instance.

The discharge from the canal is about 1851 cubic feet per second: of this, 369 feet are furnished to branch canals, leaving

1512 feet disposable for the supply of 120 outlets on the main line.

Some materials exist for enabling us to *approximate* to the loss of water caused by filtration, evaporation, and waste in general on this line. Two very careful measurements have recently been made by adding together the separate discharges of each outlet from the main canal. According to the first measurement the total amount of these was 1612.5, and according to the second, 1773; the mean being 1692 cubic feet per second. Now, as the total discharge is 1851 cubic feet, the loss on the whole length of the canal is 158.25 cubic feet, or nearly 5 cubic feet per second for each mile.

The area irrigated, exclusive of the branch canals, is 93,440 acres in summer, or 61.8 acres for each cubic foot of discharge per second. In winter, 1750 are irrigated as *marcite*, or winter meadows. The price paid for water has varied extremely. In 1376 a decree of Government fixed the water-rent per oncia at 1 lira; a decree of 1551 raised it to 36 lire; twenty years later it had reached 125 lire. By a rapid and continuous advance, the rate had become, in the beginning of the eighteenth century, 300 lire in the upper section, 400 in the centre, and 450 near Milan.

The present rates are as follows:—

	£.	s.	d.
Purchase in absolute property of 1 cubic foot per second	291	10	0
Annual rent of ditto in perpetuity, summer and winter	13	5	0
Ditto ditto for summer only ..	12	10	0
Annual rent taken from year to year, for summer ..	7	3	6
Ditto ditto for winter ..	1	5	0
Ditto ditto within 5½ miles of Milan	1	12	0

From the reckless manner in which grants have been made, the actual income is so small that it just covers the expenses. The revenue from all sources, navigation as well as irrigation, is no more than 1796*l.*, though the addition to the annual rental of the district may be very moderately estimated at 60,000*l.* per annum.

VI.—*The Cost of Constructing a Canal, and the Chief Works involved.*

No estimate is given of the cost of constructing the Naviglio Grande; but in the case of the canal of Caluso, Colonel Baird Smith, being unable to obtain as accurate accounts of actual cost as he desired, formed an approximate calculation of the probable cost of the existing works at present prices. It is as follows:—

Estimated Cost of the Caluso Canal.

	£.	s.	d.
1. Value of the land occupied by the canal and banks	1,666	13	0
2. Excavation	8,125	0	0
3. Temporary dam, head channel, banks, and head	1,458	6	0
4. Regulator, escape, divider of Castellamonte and guard-house	1,666	13	0
5. Tunnels of San Giorgio and connecting aqueduct	12,500	0	0
6. Bridges and bridge canals in masonry	3,541	13	4
7. Bridges in wood	41	13	4
8. Aqueducts of wood across canal	50	0	0
9. Walls and fall of Cassone	116	13	4
10. Retaining-walls of masonry	1,250	0	0
11. Retaining-walls of stone	1,666	13	0
12. Planking	50	0	0
13. Paving of the bed	625	0	0
14. Dividers of Arrè, Mandria, &c.	1,075	0	0
15. Sundry expenses of various kinds	1,075	0	0
Total	34,906	5	0

or rather more than 1700*l.* per mile.

For a large canal this is probably a moderate estimate, though in several cases the Government bought private canals at the rate of 1000*l.* per mile.

On the other hand, where the Government has been induced to grapple with a task of unusual difficulty, and to execute it thoroughly or even magnificently, the results have been far more costly.

The western canal from the Bormida, commenced by a private company, and completed and opened by Government under the name of Canal Charles Albert, cost in all 42,000*l.*, or 2800*l.* per mile, for a channel 15 miles long, 16½ feet broad, and 6 feet deep below the surface of the soil. The income (1500*l.* a-year) which is in great measure derived from mill-rents, after the deduction of 250*l.* for repairs, barely pays 3 per cent. on the outlay, and is never likely to exceed 5 per cent.

VII.—The Canal of Pavia.

From the time of the capture of Pavia by Milan, in 1359, a watercourse seems to have been designed to connect these towns, which was called the New Canal, in 1411. The various masters of Milan all saw the importance of connecting that city with the Po by a navigable stream, and most of them attempted, but all failed to realise this design. Finally, this the most splendid work of modern Italy owed its origin to a stroke of the pen of Napoleon I., who in June, 1805, as King of Italy, decreed as follows:—

“The canal from Milan to Pavia shall be made navigable.

The project shall be submitted before the 1st of October, and the works shall be so distributed as to be terminated within the space of eight years."

In 1807 the works were commenced according to a project furnished by the celebrated engineer Brunaoci, and for some years were carried on with vigour; but, as they were left unfinished at Napoleon's downfall, it remained for the Austrian Government to adopt the enterprise, which it completed in 1819. The works include 12 locks, 14 bridges across the canal, 16 other bridges, 8 aqueducts, 2 tunnels, 38 syphons, and "*no less than 122 works of different kinds required solely for the maintenance of the pre-existing state of irrigation.*" The execution of these works in first-rate style cost no less a sum than 296,875*l.*, or 14,800*l.* per mile; whilst the total income does not exceed 3000*l.*, of which sum nearly 1400*l.* are absorbed in repairs and establishment charges. The channel, however,—and therefore the water-supply,—is but small; the loss from filtration is large; the growth of water weeds and other obstructions have reduced the current from 225 cubic feet per second to 138; so that we must view this costly work as designed rather to promote navigation than irrigation.

VIII.—*Management of Irrigated Land.*

The characteristic features of Lombard farming are good-sized farms, chiefly in meadow, and devoted to the rearing of cattle. The permanent meadows are chiefly summer meadows, cropped only between March and September. There are also some winter meadows, "*marcite*," which are peculiar to Italian agriculture, and call for a special notice. Much advantage, however, has been derived from introducing the temporary meadow in rotation with other crops; permanent grass is only retained in localities not well adapted for general cultivation.

From the permanent meadow three cuttings of grass are derived in May, July, and September, which on an average furnish respectively 24½, 18½, and 14 cwts., or in all nearly 2 tons 17 cwts. of hay, worth 2*s.* 6*d.* per cwt. The after-grass is worth about 8*s.* per acre, and the gross value of the produce is therefore about 7*l.* 10*s.*

The temporary summer-meadows (*prati a vicenda*) are arranged similarly to the preceding in all that regards irrigation; but in the one case the land remains continuously under grass, while in the other it is so only for two or three years. "The ordinary period of rotation is for five years, in the following order:—First year, wheat, cut about the middle of July, grass-seeds being sown with the wheat. Second, third, and fourth, meadow under irrigation, and abundantly manured. Fifth, Indian corn or flax.

After flax, cut at the end of June, millet is immediately sown, and comes to maturity about the end of October of the same year. A sixth year is occasionally added to the period, when another crop of Indian corn is taken, and the rotation again commences in the same order."

"In illustration of several points connected with this subject," writes Colonel Baird Smith, "I may give here the following comparative statement of expenditure and return from irrigated and unirrigated lands in the Lumellina, which is one of the best irrigated districts in Piedmont. They were prepared by an excellent authority—a gentleman in charge of a number of the canals in the provinces of Mortara and Novara—and are the results of actual experience on a property consisting of 3750 acres. I believe, therefore, they may be accepted as tolerably correct. The originals being all in Piedmontese measures, I have reduced them throughout to their equivalents in our own.

IX.—"COMPARATIVE STATEMENT of Expenses and Returns from Irrigated and Unirrigated Land in Piedmont.

Year.	Nature of Cultivation.	Expenses.	Receipts.
First Year.	1st, Culture of one acre of good strong land in the usual rotation of five years— <i>Without Irrigation.</i>	£. s. d.	£. s. d.
Indian corn.	<i>Manuring.</i> —Purchase, carriage, and spreading of 135 cwt. of stable manure, at 4½d. each	2 10 6	
	The ploughing and harrowing are executed in return for the grass and the gleaning of the Indian corn after the harvest. Other field-work is paid for <i>en métayer</i> , with one-fourth of the produce.		
	Produce in grain, deducting seed and the portion due to the <i>métayer</i> , 21·1 bushels, at 3s. 4d. each .. .. .	..	3 12 0
Second Year.	Manure, two-thirds of the quantity used the first year	1 13 8	
Legumes.	Three ploughings and harrowings, at 4s. ..	0 12 0	
	Produce in legumes, deducting seed and portion due to the <i>métayer</i> , 18 bushels, at 3s. 11d. each .. .. .	..	3 10 6
Third Year.	One ploughing and harrowing, at 4s.	0 4 0	
	Produce in straw .. .. .	..	0 8 0
Wheat.	Produce in grain, deducting seed and portion due to the <i>métayer</i> , 17·16 bushels, at 5s. 10d. each .. .. .	..	5 0 1
Fourth Year.	Four ploughings and harrowings, at 4s. ..	0 16 0	
	Manure, as in the first year	2 10 6	
Wheat.	Produce equal to that of the third year— <i>viz.,</i>		
	Straw .. .. .	..	0 8 0
	Grain .. .. .	..	5 0 1

Year.	Nature of Cultivation.	Expenses.	Receipts.
Fifth Year.	Four ploughings and harrowings, at 4s. ..	0 16 0	
	Produce in straw .. .. .	..	0 8 0
Rye.	Produce in grain, deducting seed and portion due to the <i>métayer</i> , 17·16 bushels, at 3s. 4d. .. .. .	..	2 17 2
		9 2 8	21 3 10
	Deduct expenses .. .. .	..	9 2 8
	Net returns for five years .. .. .	.. ..	12 1 2
	Annual return per acre	2 8 2	
Means of three Years.	2nd, Culture of the same land as the preceding, converted into an irrigable meadow. The averages of three years are given.		
Meadow.	Manure.—150 cwt. of stable manure, at 4½d. each	2 16 3	
	Charges for irrigation channels and spreading manure	0 12 6	
	Watering, cutting, making, and carriage of hay	1 7 8	
	Produce of three cuttings, 72 cwt. of hay, at 2s. 4d. each .. .. .	..	8 8 0
	Rent received for pasturage after the third cutting .. .. .	..	0 8 4
	Totals	4 16 5	8 16 4
	Deduct expenses .. .. .	..	4 16 5
	Net annual produce of one acre of irrigated meadow .. .. .	..	3 19 11
	Comparative Statement.		
	Annual produce of one acre of irrigated land	3 19 11	
	Annual produce of one acre of unirrigated land	2 8 2	
	Excess per acre in favour of irrigation	1 11 9	

“The preceding details show results on strong good land in the Lumellina. It may be interesting to give an example of the same kind for light and rather inferior soil in the same locality:—

Year.	Nature of Cultivation.	Expenses.	Receipts.
First Year.	1st, Culture of an acre of light and sandy soil in a rotation of four years— <i>Unirrigated</i> .	£. s. d.	£. s. d.
	Manure as in No. 1	2 10 6	
Indian corn.	Labour is paid for <i>en métayer</i> , as in No. I., with one-fourth of the produce.		
	Net produce, deducting portion due to the <i>métayer</i> and seed, 16·7 bushels, at 3s. 4d. each .. .. .	..	2 15 8

Year.	Nature of Cultivation.	Expenses.	Receipts.
Second Year.	Manure equal to first year	2 10 6	
	Three ploughings and harrowings, at 3s. 4d. each	0 10 0	
Legumes.	Net produce, 14½ bushels, at 3s. each .. ..	..	2 16 9
Third Year.	Ploughing and harrowing	0 3 4	
	Net produce .. .. .	..	2 9 7
	Straw .. .. .	..	0 6 8
	Five ploughings and harrowings, at 3s. 4d. Net produce	0 16 8	2 9 7
Fourth Year.	Straw .. .. .	..	0 6 8
	Totals	4 0 6	11 4 11
Rye.	Deduct expenses .. .. .	..	4 0 6
	Net returns for four years .. .. .	..	7 4 5
	Annual return per acre	1 16 1	
	2nd, Culture of an acre of the same land as the preceding, converted into an irrigated meadow. Averages of three years.		
	Manure.—150 cwt. of manure, at 4½d. each	2 16 3	
	Cost of irrigated channels and spreading manure	0 12 0	
	Cost of watering, cutting, making, &c.	1 2 9	
	Produce of three cuttings, 60 cwt. of hay, at 2s. 4d. each .. .. .	..	7 0 0
	Received for pasturage after third cutting .. ..	..	0 5 0
	Totals	4 11 0	7 5 0
	Deduct expenses .. .. .	..	4 11 0
	Annual net return of one acre of irrigated meadow .. .. .	..	2 14 0
	Comparative Statement.		
	Annual net produce of one acre of irrigated land	2 14 0	
	Annual net produce of one acre of un-irrigated land	1 16 1	
	Excess per acre in favour of irrigation	0 17 11	

“The preceding details apply to summer irrigation in Piedmont; the following show the net rent derived from a farm of about 350 acres thoroughly irrigated, in the province of Milan:—

	£.	s.	d.
Rent in money paid to the landlord per acre	1	19	6
Minor items paid in kind	0	1	3
Communal (parish) charges paid by the tenant	0	1	8
Government charges paid by tenant	0	9	4
Proceeds of sale of wood reserved by the landlord	0	1	9
Gross rent per acre	2	13	6

Deduct proportion of expenses paid by the landlord
as follows:—

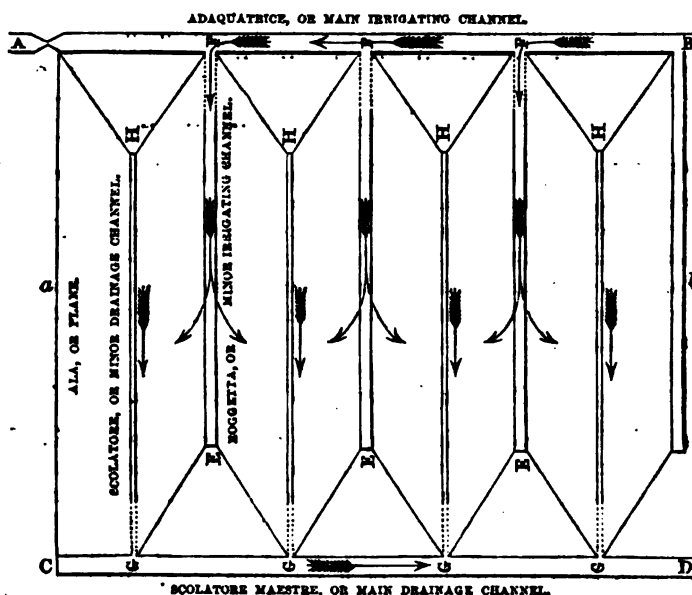
	£.	s.	d.
Government and communal charges	0	11	0
Repairs of buildings and hydraulic works	0	2	9
Expense of administration, inspections by en- gineers, &c.	0	2	0
	<hr/> 0 15 9		
Net rent per acre	1	17	9

"Such land as is referred to in these details sells for from 40*l.* to 45*l.* per acre; so that the interest on capital thus invested does not much exceed 4 per cent. The gross returns from irrigated meadow land in the Milanese have formerly been estimated at 7*l.* 8*s.* per acre; and, if these data are to be depended upon, it would appear that the rent is just one-fourth of the total amount of these returns."

X.—The Laying-out of Water-Meadows.

A principal feature in preparing a water meadow is the sloping of the land, that the water may be spread in a thin uniform sheet over its surface. In extreme cases this work costs 10*l.* to 12*l.* per acre. The slope given varies greatly, according to the soil and locality, being eight or ten times as great in some absorptive soils as in those of a retentive clay. "Colombani mentions that for summer meadows in the province of Lodi, the breadth in the direction of the slope is 140 metres, or nearly 460 feet; while the length in the direction transverse to the slope is 180 metres, or 590 feet, which would make each of the great compartments contain an area of 6 acres English. To each such compartment a main irrigating channel, of about 3 feet in breadth, running in a direction transverse to the slope, is allotted;"—"in summer meadows it is not usual to have main channels." The slope given to the surface of the meadow is, when practicable, two-tenths per 100; or, in English measure, about 3 inches in each 100 feet. Practically an interminable variety of dimensions prevail, as regulated by the instinct of the *campari*, or professional designers of water meadows. To state an instance of these variations, Signor Berra, in his detailed instructions for forming water meadows, recommends that the main channel having been marked out on the highest level of the field, minor irrigating channels should be drawn at right angles to it, so as to divide the field into compartments "*piane*," which should never be more than 25 to 30 feet in breadth, and eight or ten times as long as they are broad; the planes should slope from the minor channel on each side $\frac{1}{3}$ in 1; or, when the breadth is 30 feet, the slope would be very nearly 12 inches.

The following illustration is given of the arrangement of a *marcite* field:—



SECTION ON a b.



- A B, Main Irrigating Channel.
 C D, Main Drainage Channel.
 E F, Minor Irrigating Channels, generally 12 inches wide, and 6 or 7 deep.
 G H, Minor Drainage Channels, about half the above dimensions.

A provision for drainage is of course made at the base of each slope, in a manner familiar to us all; but the value attached to the surplus waters, *colatori*, is more of a novelty. These, "having passed over lands richly manured, have a value often considerably superior to their original one." Their temperature becomes higher as they flow, partly from mechanical, and partly from chemical causes; it being customary to apply to the upper meadows the richest manure, which is supposed to raise the temperature of the water, a point much insisted on for winter meadows. It is therefore calculated that water, before it is exhausted or dismissed from service, will have enriched double the area of the meadow which it first supplied; and the surplus

water may claim the same right of passage through a neighbouring estate for a second or third application, as it originally enjoyed when issuing from the canal.

XI.—The Tenure of Land, and the “*Consegna*,” or Lease.

Improved farming has found in Italy its natural, if not necessary attendant, in the improved tenure of the land. On irrigated farms, requiring tenants of capital and intelligence, a money rent and a lease for nine to eighteen years has generally superseded the older *affitto a mezzadria*, under which the produce was divided between landlord and tenant.

Under the older tenure the proprietor is bound to deliver over the farm in a good state for culture, to bear the expense of breaking up uncultivated lands, and to prune and keep up the plantations of mulberry, &c. The cultivator does all the labour; pays for half the wood required for vineyards; provides half the silkworm seed; furnishes straw in small quantities; gives his labour, when required, at a rate fixed in the contract; and pays a rent for the dwelling. As the cattle are generally his property, he receives the whole profit derived from them, as well as the manure; the proceeds of the poultry-yard and kitchen garden are likewise his. He is bound to deliver the whole of the other products of the farm into the granaries of the proprietor, receiving credit for the half of their value, or whatever different proportion may have been agreed upon.

The complications and disagreements arising out of this tenure have led to a modification of it, termed *affitto a grano*, “by which the cultivator is bound to deliver into the granaries of the proprietor a fixed quantity of wheat, varying from 14 to 20 bushels for each acre under cultivation, all the other products of the soil remaining at his disposal. The produce of the plantations, whether vines or mulberries, belongs to the proprietor, who gives the cultivator credit for half their value; the minor arrangements are generally the same as in the *affitto a mezzadria*.”

This change is attended by the serious drawback that the tenant is thus constrained to have nearly two-thirds of his farm in wheat. But the more modern *affitto a denaro*—money-rent—with its attendant *consegna*, or valuation, is now preferred in irrigated districts, and on the larger estates belonging to the Church, the hospitals, or the communes, or to private landowners, especially minors; and of this improvement the Lombards are justly proud. The tenant, besides paying his rent, generally covenants to add to the plantations, make certain improvements, and furnish some small supplies, such as rice, poultry, &c., in kind. Of the *consegna*, Colonel Baird Smith writes as follows: “Prepa-

ratory to the entrance of the tenant, the proprietor appoints an engineer to make a most elaborate statistical survey and valuation of the farm, with all its fixtures and stock. This document, of which I have seen many examples, is a perfect record of the condition of the farm when the tenant receives it, and is locally termed the *consegna*. The tenant is at perfect liberty to associate an engineer of his own nomination with the party employed by the proprietor—a right which is frequently exercised. On my asking a friend, who had much experience in such matters, how possible disputes between the engineers were adjusted, his reply was, that the system had been so long established, and was now so thoroughly understood, that disputes were very rare indeed; but that, when they did occur, the universal feeling in the profession was to give the tenant the benefit of any doubts that might arise." In the *consegna* the engineer describes every field separately, indicating its position, form, size, cultivation, enclosures, living and dead, the canals, sluices, bridges, roads, paths, buildings, with all their furniture and fittings. The plantations of mulberry, &c., are numbered tree by tree, and are divided into separate classes according to their quality and dimensions, each class having an established value. If at the termination of the lease, which varies from nine to eighteen years, the plantations have decreased, the tenant is debited with the value of the difference; while, on the other hand, if they have increased, the value of this increase is placed to his credit.

"When the period of this lease expires, the engineers are again summoned to frame another survey, which is termed the *reconsegna*. In this the same minute details are entered into as in the *consegna*. A comparison is then instituted between these two documents, and a *bilancio*, or balance-sheet, showing the differences between them, is prepared. In this balance-sheet every deterioration and every amelioration are exhibited, with the money-value placed upon them by the engineer: the tenant finds himself debited with the first and credited with the second, and has either to pay to or receive from his landlord certain sums, according to the results of his own administration of the farm he has held. The system works admirably. I found all parties, landlords and tenants, alike contented with it, and indeed proud of its existence among them. It maintains a very satisfactory state of feeling between the two classes; for the tenant is encouraged to invest any capital he may have in improving the farm, being sure of receiving a just return for it, while the landlord has his property permanently benefited by the labours of an intelligent and interested man. It constantly happens that leases are renewed term after term for successive generations."

XII.—*The School of Engineers.*

This enviable picture would perhaps but mislead us if it were unaccompanied by some account of the Italian engineer—his training and social position. First, the Italian school of engineers is coeval with its irrigation. "With the revival of knowledge in Italy," writes Colonel Baird Smith, "the art of hydraulic engineering was called into existence." Again he speaks of "the high character and qualifications of that immense body of hydraulic-engineers which has been created by the general development of the system of irrigation, and its intimate relations with the rights of property and the progress of improvement." And again: "The judicial authorities base all their decisions, in all questions of hydraulic art, on their evidence. And, under the general name of *periti*, we find them holding an important position in the whole course of the legislation of irrigation from the earliest times to the present day. The discharge of the duties required at their hands is always delicate and difficult; but as a class they are universally respected for general efficiency, good faith, and professional honour."

Of the engineers of Lombardy Colonel Baird Smith writes: "It will be readily understood how important a part they are required to take in the whole agricultural system. Not only do they design and superintend the construction of various kinds of works, whether ordinary or hydraulic, which are required, but the whole of the details of leases, the preparation of the various documents required on the part of landlord and tenant, and advice as to the different improvements of which the land may be susceptible, are committed to or required of them. The profession is consequently one of the highest utility. The education of the young engineers is very carefully attended to, and involves four years of apprenticeship to an established engineer. Degrees, as in Piedmont, are given at the University of Pavia; and I must state that, after having been in personal communication with a large number of the class, I formed a high estimate of their professional ability and general intelligence. The requirements of the system have called into existence a special division of the profession, who, under the title of *Ingegneri Avvocati*, are employed in all cases involving legal questions in hydraulics. To illustrate the demand for engineers, I was informed, perhaps with some exaggeration, that in Milan alone there were not less than 400; while many more are of course spread abroad over the face of the country."

The above reference to Piedmont is thus explained:—

"The profession of the civil engineer in Piedmont is divided into three grades, of which the highest is the hydraulic engineer;

the second, the civil architect; and the third, the surveyor or measurer. For the superior degree the course of study extends over four years. Before entering the university at all, the engineer student must pass an examination, which embraces arithmetic, elementary geometry, and algebra, to equations of the second degree. In the university course the first year is devoted to the farther study of algebra, of trigonometry, and of analytic geometry; the second, to the differential and integral calculus and descriptive geometry; the third to the principles of mechanical philosophy and their applications to machines, with practical geometry—under which term are included surveying, levelling, plan-drawing, and other professional details of this order. The last year is devoted to the study of construction in theory and practice as applied to ordinary and hydraulic work. During the first three years the student is obliged to attend the school of architectural design; and at the close of each year an examination in the subjects of that year's studies has to be passed before any farther advance is permitted. Before taking the degree of hydraulic-engineer, two special examinations have to be passed—one private, which embraces the range of the last two years' studies; the other public, on three theses selected by the student himself from forty-five propositions prepared by the professors of mechanics, of construction and of hydraulics. A fourth theme is prescribed specially by the professor of hydraulics, and is designed to test the practical knowledge of the young engineer. It is in the form of a project for a bridge, or a dam, or a hydraulic-machine, or a canal; and the student is required to submit every detail, with regular plans, estimates of probable cost, and calculations of materials, &c. When these various tests have been satisfactorily submitted to, the student receives his diploma, and is entitled to exercise his profession either as a member of the government corps of civil engineers, or privately, as may suit his personal views. The names of the most distinguished pupils are each year submitted to the Government, and published in the official gazette."

In Italy, therefore, the callings of the civil engineer and the land valuer are united into one profession, and a thorough professional education is an indispensable preliminary to its exercise. We have not yet reached this point of civilisation, and though in our agricultural difficulties we may have a choice of very many valuable advisers and referees, in whom practical good sense and sterling honesty may compensate for a possibly defective education, still we have no guarantee that our fate may not depend on a self-constituted arbiter, in whom some insight into the capabilities of land, and shrewdness at driving a bargain, have to make up for an absence of all professional, and almost all

general education. Those who are anxious to copy the Italian model must consider whether they can dispense with its safeguards.

XIII.—Springs.

The springs (*fontanili*) of Northern Italy are powerful auxiliaries to the canals, even if sometimes they borrow before bestowing the supplies which they profess to furnish. The whole plain between the Alps and the Po is underlaid by a water-bearing stratum. The springs which rise from this stratum have a considerable volume and a high temperature, consequent on the depth of their source, which gives them a special value for *marcîte*.

A spring-head near Milan is thus described. An excavation was formed 200 feet long 100 feet wide, and about 8 feet deep. Over the surface thus laid open 42 separate springs, each enclosed within its wooden case, were to be seen, the united discharge of which amounted to nearly 12 cubic feet per second, which at the ordinary local value of water was worth nearly 4000*l*.

The sinking of some of these wooden tubes had been very laborious and costly, but they were unusually large—8 feet in diameter.

The stream which issues forth runs half-a-mile before it tops the level of the fields; it then supplies a flow of 10 cubic feet per second for the irrigation of about 30 acres of winter meadow. It is calculated that the springs of Lombardy furnish in all about 2000 cubic feet per second, those of Piedmont 1000, and that their united value is 840,000*l*.

Besides these recognised supplies, the canals in their passage are often largely but secretly recruited from this source; the Naviglio Taverna, in particular, which draws only 15 cubic feet from the Martesana, affording a discharge of nearly 30.

In *prospecting* such springs, although the use of the old divining-rod is not quite abandoned, the flight of gnats and signs of unusual verdure are more relied on.

All springs are by law the private property of the persons on whose land they are found, but a curious instance is cited of a property watered by the spring which rises on an adjacent estate, the proprietor resting his right solely upon usage.

To protect vested interests early Milanese statutes enacted that no new spring-head should be formed within 68 feet of the bank of a public river, or within 490 feet of an existing spring; whilst within 325 feet of the banks of the Tartaro, it was forbidden to use new springs for irrigation, even should they be exposed by natural movements of the water itself.

Modern legislation has discontinued the prescription of specific

distances, leaving these to be determined in each case by the evidence of practical men, according to the peculiarities of the soil, depth of the springs, &c.

By the law of Lombardy, dated 1804, it is forbidden to excavate or open springs, or heads of springs, water-courses, and channels, as also to deepen or increase the dimensions of excavations or springs actually existing in the vicinity of rivers and canals within the distances which, according to the judgment of practical men, would lead to injury to the rivers or canals, or to their banks. With this reservation it is permitted to every one to excavate springs on his own land, and to conduct the same, respect being always had to any rights which other parties may possess.

XIV.—*The Price of Water.**

The area of land which a given quantity of water can fertilise depends both on the soil and the cropping, and likewise on the care with which the surplus waters are economised—this economy being intimately connected with the very varying price charged for water in each district, which is in itself a striking feature of this subject. If we begin our inquiries in the east of Sardinia with an important canal, such as that of Caluso, which has been wrested from its former proprietors by the State, we find that the charge for water is 7*l.* to 8*l.* for a flow of 1 cubic foot per second; that this suffices for 51 acres of land, and therefore costs 3*s.* per acre. But as we go westward, and especially when we meet with private canals, the water charge rises to from 16*l.* to 21*l.*, the charge per acre, to from 8*s.* to 16*s.*, and the area irrigated, to from 45 to 56 acres. On the canal Roggia Sartirana the price for water is the highest in Sardinia, viz., 42*l.* per cubic foot, or, *as it is stated*, 20*s.* (? 13*s.* 5*d.*) per acre for 63 acres. This canal, constructed by Count Sartirana A.D. 1380, is still owned by his family, to which, in spite of many free grants, it brings in a net income of 3500*l.*, besides irrigating the family property. The charge of 42*l.* per cubic foot on the canal Langosco, now belonging to a company, has led to its supplying 77½ acres at the rate of 11*s.* per acre. On the Castellana the charge is 20*l.*, and the area irrigated 80 acres; on the Agogna the charge is 35*l.*, and the area as much as 90 acres.

In Lombardy we find on the Naviglio Grande a low rate of charge, viz., 7*l.* to 13*l.*, for an area of 60 to 70 acres, and this seems the customary rate for the Government canals in that country, with a curious exception on the Muezza Canal, where an old tariff has survived, limiting the charge to 16*s.* 6*d.* per

* A flow of 1 cubic foot per second, the basis of these calculations, is taken to be equivalent to 28·3 litres, or 6·226 English gallons.

cubic foot, which is applied to an area of 83 acres at a cost of about 3*d.* per acre.

The broad distinction thus lies between districts charged 7*l.* to 13*l.* per cubic foot per second and 3*s.* or 4*s.* per acre, and those which pay up to 40*l.* and contrive to supply about 80 acres at the rate of 10*s.* per acre.

As to the quantity of water to be given to meadow-land, Colonel Baird Smith tells us that there is a great variety of opinion. "According to an experiment of De Regi," he writes, "the continued discharge of 1 cubic foot per second is sufficient for the irrigation in 24 hours of 4 acres. Hence, as the total volume discharged in that time amounts to 86,400 cubic feet, and the area watered to 174,240 square feet, it appears that a stratum of water equal to nearly 6 inches in depth was in this case spread over the surface of the meadow." As the general period of rotation may be taken at 14 days, the cubic foot would suffice for (12+4) 48 acres, there being 12 periods of 14 days in the summer season. "The above estimate, however, implies that the whole water is absorbed by the soil, which, in point of fact, is never the case. Lombard engineers calculate the absorption in each watering as ranging from one-half to one-third of the total quantity of water employed.

Effectively, the irrigating power of any given quantity of water employed in meadow irrigation is twice the area watered on the first application.

But the Lombard farmer by no means relies exclusively on the fertilising power of water, but manures freely—especially his winter meadows; for these last pig-manure, applied in a liquid form, has the preference, and it is calculated that 3 pigs kept throughout the year suffice for 1 acre. Stock-manure is combined with the earth taken out of the carriers, &c., and applied at the rate of 12 tons per acre, or linseed oilcake (!), mixed with one-seventh of its weight of lime, is given at the rate of 15 cwt. as a dressing. The application of sewage is not as general as we may imagine; a proper system of sewers having been organised in a part only of Milan, the rest of Italy retaining the use of the night-cart.

XV.—*On the Measurement of Water.*

The history of irrigation abounds with warnings as to the "danger of allowing a great system of irrigation to develop itself without well-defined regulations—of permitting interests to grow up either in ignorance or neglect, which, infringing the rights of government, oppose themselves afterwards with obstinacy and vigour to improvement of any kind." At the same time it is

better to commence with any measure—any rule, however imperfect—than with uncontrolled service. In fixing the mode of charge for water, the choice clearly lies between looking to the area irrigated, or to the size and form of the outlet through which the water flows. The former standard is found in many respects objectionable:—1st. The area irrigated will vary from year to year, and will yearly have to be measured, whereby a door is opened for fraudulent collusion on the part of subordinate officials. 2ndly. The cultivator will for some crops risk the chances of a rainy season, and in a gambling spirit defer the proper application of water. It is best, then, to regulate the charge by the size and form of the outlet.

But this regulation of the outlet has been found to be a more difficult problem than may at first sight be imagined.

At a very early period it was discovered that the size of the aperture was an insufficient test, and that account must be taken of the water's velocity. In 1570, when the scientific principles of hydraulics were scarcely known, Soldati invented his *modulo*, constructed on purely empirical data; and in 1643 Torricelli published his theorem for determining the velocity of fluids; "but, in truth, there is no branch of physics in which the theoretical correspond less with the observed results than in hydraulics." Slight variations in the force of gravity itself; in the resistance of the air; in that of the water into which the discharge takes place; modifications in the form of material or inclination of the chamber of supply; or in the thickness and perimeter of the outlet itself; in the freedom of the water's escape from that outlet, as well as in the velocity with which it enters the supply-chamber: all these exercise disturbing influences, even when the head of water is fixed.

Already in the sixteenth century, in the days of Soldati, the conditions of perfect success were laid before that engineer by the magistracy of Milan, and of these conditions Colonel Baird Smith writes, "it is clear that to satisfy them all perfectly would be impracticable, even with the increased knowledge of the present day."

The conditions were briefly these:—"1st. To establish a just and exact unity of measure. 2nd. To devise a form of apparatus for the outlets, which would be injurious neither to the state, nor to the consumers of the water, nor to the navigation of the canal. 3rd. To protect the apparatus from all risk of alteration in its essential parts by the cultivators. 4th. That precautions should be taken against infiltration from the main canal into the private channels. 5th. To regulate the velocity of the stream passing through the outlet, so as to render it as far as possible independent of the velocity of the main canal. 6th. To ensure the same dis-

charge from the new form of outlet in summer and in winter. 7th. To establish, in the event of a deficiency of supply in the main canal, a fair method of decreasing proportionally the discharges of the different outlets. 8th. To provide for the possible contingency of a permanent increase in the supply of the main canal, so as to prevent in such case the consumers from getting more than their fair share of the water. 9th. To make the discharge of the outlets independent of variations in the level of the bottom or bed of the main canal. 10th. To establish, by some unalterable mark, the true level of the bed of the main canal at each outlet, so that it might be at all times recognisable with facility, and verified whenever necessary. 11th. To devise such a system of management of the outlets as to place in the hands of the Government officers the power of either closing them altogether, or diminishing their discharge with facility in all periods of extreme dryness. 12th. To point out in detail the best means of reconciling the often conflicting interests of navigation and irrigation, so that, in periods of extreme dryness, the quantity of water essential for the former might be maintained with the least possible inconvenience to the latter."

Of this problem the three fundamental conditions are:—

1. To indicate the best unit for the measurement of water employed in irrigation, and such a method of distributing it as shall be injurious neither to the public treasury, to navigation, nor to the consumers.
2. To discover an apparatus which shall discharge in a given time, by an outlet of fixed dimensions, a constant volume of water, whatever may be the variations in the level of the supplying canal.
3. To construct the apparatus so that it should oppose all possible obstacles to fraud.

The unit of measure, *uncia magistrale*, fixed on by Soldati, is that quantity of water which flows freely, or under the sole influence of pressure, through a rectangular opening, having a uniform height of 7·4 local inches (7·86 English inches), a breadth of 3 (4·12 English), and a constant pressure of 2 local inches (3·93 English) above the upper edge of the outlet.

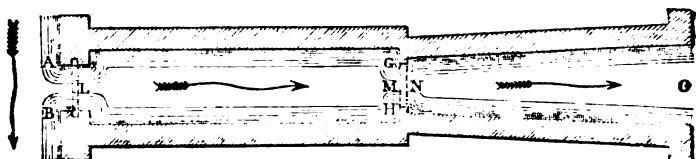
For larger discharges the breadth was doubled, trebled, &c., a practice which leads to irregularities favourable to the larger openings. The outlets are cut in a single slab of stone, and fitted with an iron rim.

The apparatus required was found in Soldati's Modulo Milanese, which, with some modifications, is in use at the present day.

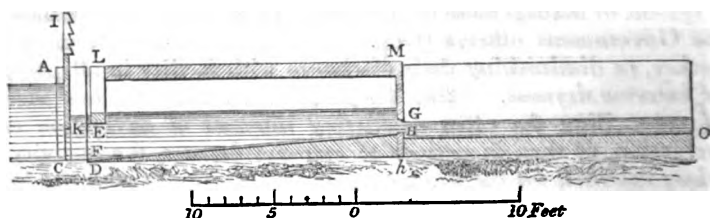
To explain its present arrangements, Colonel Baird Smith published a plan and sections, copies of which are given below,

taken from the original blocks, for the use of which we are indebted to the courtesy of his representatives.

MODULO MAGISTRALE OF MILAN.



Plan. Fig. 1.



Longitudinal Section. Fig. 2.

"The head A B, Fig. 1, is placed on the bank of the canal of supply with the sill C D, Fig. 2, on the same level as the bottom of this canal. It is formed of two side-walls or cheeks, of good masonry, in brick or stone, with a flooring generally of the latter material. To prevent erosive action, the bed of the canal, for such distance as the force of the current may render necessary, is paved with slabs of stone or boulders, both above and below the head. The outlet of the head is usually made of the same breadth as that of the measuring orifice G H, Fig. 2; while its height is regulated by that of the head itself. The sluice-gate or *paratoja*, I K, Fig. 2, works in grooves, and is fitted with a rack and lever, by which it can be readily raised or depressed at pleasure. As the surface level of the canals of the Milanese varies comparatively little, the upright of the sluice has a small catch in iron or wood attached to it, by which it is kept at a fixed height corresponding to the requisite pressure on the orifice G H, Fig. 2. This little catch is locally termed the *gattello*; and as it is provided with a lock and key, the latter of which is intrusted to the guardian of the canal, the proprietor of the water-course is supposed to be restricted to his legitimate supply; and probably is so, within reasonable limits, provided always that the guardian is incorruptible.

"In rear of the sluice-gate at the head is placed the first chamber, L M, Figs. 1 and 2, called in the language of irriga-

tion, the *tromba coperta*, or covered chamber. It has, in the established form of the *modulo*, a fixed length of 10 *braccia*, equal to very nearly 20 English feet, and a breadth variable according to the size of the head-sluiice, which it exceeds by the fixed quantity of 5 local inches on each side, or 10 on the entire breadth, being nearly 1·64 English feet. The bottom of the covered chamber, D H, Fig. 2, is formed with a slope to the rear, or as a ramp: the height of this slope, H h, is equal to 8 local inches, or $15\frac{1}{2}$ English inches very nearly; and its object is to diminish the velocity with which the water reaches the measuring outlet G H. Farther to assist in effecting this object, the perfect *modulo* is provided with a horizontal top of stone slabs, or planks, called the *cielo morto*, the under surface of which is at precisely the same height as the water ought to have over the outlet G H, so as to secure the fixed discharge; that is, 3·93 English inches above the upper edge of G H. The great purpose of the apparatus being to secure the discharge taking place under simple pressure, the *cielo morto*, which may be roughly rendered the *deadening cover*, is found to reduce the irregular motion of the water in passing from the sluice A B to the measuring outlet G H.

“To admit of ready inspection of the state of the water within the covered chamber, the following arrangements are made:—The entrance to the chamber is covered by a stone slab of convenient thickness, shown in section at E, Fig. 2, the lower surface of which is precisely on the same level as the upper edge of the outlet G H. The height of the ramp H h being 15·72, and that of the outlet G H being 7·86, the surface of the slab at E should be just 23·58 English inches above the sill of the head C D. An open groove, L D, is made in the masonry, large enough to admit a graduated rod or measure; and when the water stands at a height of $(23·58 + 3·93)$ 27·51 inches above the sill at D, it is known that the proper head of pressure exists at G H. As it is found to be greater or less, the sluice is raised or depressed, so as to adjust the pressure to the fixed standard.

“The slab of stone in which the measuring outlet is cut being fixed at G H, Figs. 1 and 2, immediately in rear of it there is placed the *tromba scoperta*, or open chamber. Its breadth at N, Fig. 1, is two local inches, or 3·93 English inches greater on each side than that of the measuring outlet; or in all, 7·86 inches. Its total length, N O, is very nearly $17\frac{1}{2}$ English feet. Its side-walls, which are perpendicular like those of the covered chamber, have a splay outwards, so that the breadth at O is 11·79 inches greater than at N, or 15·72 inches in excess of that of the regulating outlet G H, being the same as that of the covered chamber throughout. To insure the free run of the water from G H, the

flooring of the open chamber has a drop or fall of 1.96 inches at H, and an equal quantity distributed uniformly between H and O, Fig. 2. There is, therefore, a total fall from the under edge or lip of the measuring outlet to the end of the open chamber of 3.93 inches; or—as the length is 17.72 feet—very nearly 1 inch in 54. When the water reaches O, it enters the channel of distribution, and becomes the property either temporarily or permanently of the parties to whom the grant of it has been made. Arrangements at O vary. Sometimes there is a fall from the end of the *modulo* to the bed of the channel; but generally the two are on the same level, the latter being carried forward at the usual slope for such works.

“From the preceding details, it therefore appears that the *modulo magistrale*, in its normal form, has a length of nearly $37\frac{1}{2}$ English feet, and a breadth variable according to the quantity of water it is designed to measure. If a single ‘water-inch,’ for example, be the volume, the breadth of the covered chamber would be 25.54 inches, and that of the open chamber 13.75 at its upper, and 25.54 at its lower extremity. The flooring of the former rises 15.72 to the rear, while that of the latter falls 3.93 in the same direction.

“It is essential to the effective operation of the regulating sluice in the *modulo magistrale*, that there should be a difference of level between the water in the canal and in the apparatus of at least 7.86 inches; and as the height of water in the latter must be 27.51 inches, the depth of water in the canal of supply must necessarily be not less than the sum of these numbers, or 35.37, being very nearly 3 feet. In this case the relative heights of different parts of the works are given below, the bottom of the canal of supply being the zero line.

	English inches.
“Bottom of the canal	0.00
Level of the water in the canal	35.37
Level of the water in the interior of the <i>modulo</i> giving the constant pressure	27.51
Level of under surface of the stone slab at the mouth of the covered chamber, and of the upper edge of the measuring outlet	23.58
Level of lower edge of measuring apparatus at the end of the ramp of the flooring of the covered chamber	15.72
Level of the flooring at the head of the open chamber ..	13.75
Level of the flooring at the termination of the open chamber ..	11.79.”

In Sardinia a rule for the water measure is prospectively prescribed in the 643rd Article of their Civil Code. For the details of their plan, I must refer the reader to Colonel Baird Smith’s work, remarking that custom there so much overrides the law, that in the canal of Caluso “there is scarcely an outlet in which the prescribed limits are observed;” and that a practice of

making outlets *a fior d'acqua*, or "level with the surface of the water of the canal or reservoir," has been an obstacle in their path.

XVI.—*The Law and Course of Legislation respecting Water.*

The laws affecting irrigation in Italy, as elsewhere, appear to have been based on immemorial usage; even the earliest record—the Statutes of Milan of 1216, preserved in the Ambrosian Library—so regards them. Before this time, however, the irruption of the Northern barbarians had given a shock to all pre-existing rights, which, though rude, may have been in some respects serviceable. All rights appertaining to the public had been centred in the feudal lord, who exercised them not merely for purposes of police, but as his *absolute property*. As the fiefs were large and few, in dealing with rivers and watercourses this state of property was favourable for a mutual understanding being arrived at.

When the free Lombard League wrung from the Emperor Frederick I., the Peace of Constance, A.D. 1183, the Italian towns were not so much restored to their former rights, as endowed with all those lately vested in the feudal superiors, including the ownership of the rivers. Except in so far as the state has by sale or grant transferred its rights to individuals, corporations, or associations, this rule respecting rivers has been maintained; and at the present day, "as in Lombardy so in Piedmont the right of property of all running water is reserved to the state."

The free towns invested with full powers soon began to turn them to account. In 1216 Brunasio Porcha, Podesta of Milan, published a code of laws to regulate the use of water, which embodies all the leading ideas of modern legislation. The following are its chief regulations:—

"1. Whoever has the right to obtain water from springs or rivers, or in any other manner whatsoever, can carry it through the fields and farms of any individual, commune, or public corporation in this state, and also across the public road.

"2. To this end he can construct the canals or channels, and other necessary works at the least possible inconvenience and injury to the proprietors of the farms, paying one-fourth more than the true value of the land thereby occupied.

"3. In addition he must repair all damages caused by the water, according to the estimate of two practical men (*periti*),—provided, however, that the compensation for damages shall in no case exceed twice the value of the property damaged.

"4. He shall be bound to maintain in efficient repair, at his own expense, the bridges and drains required for the passage of

the water, whether on the farms, or across the roads, so that these latter shall suffer no injury, especially in rainy weather.

"5. The water may be conducted, or caused to pass, above or below canals previously existing, new channels of brick or lime being made for it in such manner as that the water flowing under, shall not be mixed with that flowing over, or within the pre-existing canals.

"6. These new channels must be maintained in such condition as that the proprietor of the water at the upper levels shall suffer no damage from the reflux of the same. The water shall have a free and unobstructed course."

The Visconti, the French, the Spaniards all re-enacted these laws with some additional details; and the Republic of Venice applied a similar system to its territory of Verona. After the outbreak of the French Revolution and the wars in Italy, many of the old laws having been swept away in 1802, it was found necessary, in 1804, to re-enact the statutes of Charles V. respecting irrigation; and it is remarkable that, when the Austrians at their accession to power removed from their new code, in 1816, the "right of passage" in consequence of the troubles and disputes which arose, the Aulic Council was constrained to restore it in 1820.

Piedmont, though it cannot point to records and statutes as old as those of Lombardy, has followed the same general course; and her modern code fully and clearly provides for the protection of rights connected with irrigation. Under this law, a proprietor wishing to have the use of water employs an engineer to draw up a petition to the Intendant of his province, stating the proposed objects, with explanatory plans and sections. The Intendant then directs the Government engineer to inspect the spot, and report on the petition; and later, forwards both the petition and the report with his own comments, to the Secretary of Finance, whose duty it is to obtain the Royal sanction.

The chief benefits of this organisation are, that a proprietor desirous of using water knows distinctly where to apply for a sanction; and when his application and offer are approved, can go fearlessly to work to carry out his plan. The keystone of the whole fabric is the "right of passage" or transit for your supply of water across your neighbour's land—an invasion of the general law of property, which experience has shown to work so much for the common good, that in the words of Giovannetti at the close of his elaborate report, "it may be frankly stated that in northern Italy the right of passage has received the most solemn sanction, popular, political, and legal." Both old and modern codes, as quoted by Colonel Baird Smith, guard carefully against the abuse of this right. The rate at which land taken for this purpose shall be paid for, varies considerably; the price has been as much as

doubled, but an excess of one-fourth, one-seventh, and one-eighth have been at different times sanctioned in Lombardy; while the 627th Article of the modern Code of Sardinia assigns "the estimated value of the land to be occupied, without deducting the land-tax or any other burdens which may be inherent in the soil, together with one-fifth of the said value in excess, and also compensation for immediate damages including those due to the division of the estate into two or more parts, or any other deterioration which may follow the intersection of the land."

From its first origin this right of passage was held to be a simple *servitude* on the land, the ownership remaining with the original landlord, who continued to pay the land-tax and other burdens. The nature of such servitudes is very clearly stated in the 7th chapter of the Austrian Civil Code, as quoted by Colonel Baird Smith.

In Lombardy the control of a great body of water has practically passed out of the hands of Government, so far as the details of management are concerned. In early days the municipal government always resolutely contested with their foreign masters, French or Spanish, this branch of administration; and in times when rulers were poor, wealthy corporations (such as monasteries or hospitals), or powerful chieftains, by payment or grant secured to themselves the right to employ large volumes of water, and were thus relieved from all harassing interference in applying them to their own use, or in disposing of them to others.

This has been the origin of very powerful associations, which at times have set the Government at defiance, and by their selfishness caused "most serious obstacles to the development of irrigation." But of late Government has claimed and exercised a power of moderating their action, on the principle that such works were sanctioned for the general good of the community, an end which alone could justify the partial violation of the rights of private property then permitted. Companies, therefore, are not allowed to raise their prices, or divert their supplies in an arbitrary manner. Under a right called the *diritto d'insistenza*, acknowledged by legislative tribunals, an irrigator has a legal claim to the continuance of a supply of water, long enjoyed, on the faith of which supply expense has been incurred; and a change in the rate of payment must be referred to arbitrators nominated by both parties.

One special abuse to which the exercise of the right of passage is exposed, is, when the excavation of a very trifling spring is made a pretext for making a channel near to an older channel, or across irrigated fields with a view of drawing an additional supply from these sources. To guard against this, the claimant must show that his own supply is adequate for the purpose he contemplates.

But further, the 560th Article of the Sardinian Code enacts that the proprietor of water is not at liberty so to dispose of it as to cause it to be lost to the injury of lands at lower level. A curious anecdote in illustration of this point was related by the late Count Cavour :—

“In 1832, the Marquis of St. G——, farmer of the canals of the Vercellese, having quarrelled with his neighbour the Marquis of Pal——, persisted during eight consecutive years on throwing into the river Po two *ruote* (about 24 cubic feet per second) of water, for which the Marquis Pal—— offered to pay him 500*l.* a-year. To satisfy a personal antipathy, M. de St. G—— sacrificed 4000*l.*, causing at the same time a loss to the agriculture of his country of triple this amount at the least.”

The new code put an end to this deplorable state of affairs. It required, however, a decision of the Senate of Turin based on Article 560 of the Code to compel the Marquis of St. G—— to have his revenue increased by 500*l.* a-year. A like attempt of the same Marquis to coerce a neighbouring Commune is also recorded.

Conclusion.

We have now passed in review a few of the leading features of Italian irrigation, omitting many interesting particulars, such as the history of the growth of rice, its peculiarities and influence on health; the regulations adopted for distributing a supply of water for a certain number of hours among different proprietors in rotation; the long-established system of local administration by boards of proprietors interested in canals; the Censimento, or revenue survey; and the general influence of irrigation on population and climate; whilst ample stores of information, derived from a comparison of the state and prospects of India with those of Italy, have been entirely passed over.

If we attempt to compare the position of Italy with that of England, and look first to her natural advantages, we may remark that, although these are undoubtedly great and in some degree peculiar, still England has received no mean provision, and for its use, such as it is, we are responsible.

The social advantages by which Italy has profited are more critical, and therefore less easy to criticise.

The chief point seems to have been that the right to use or grant the use of water was there vested in some one authority, and was not a common right, to be used at each man's discretion within the bounds of discretion, and guarded by the mutual jealousy of all. As what is every man's business is nobody's business, so it sometimes happens that what all may enjoy in common, no one practically can turn to the best account.

With common *lands* we have recognised this as a truth, and

acted on the conviction; yet in a bygone agricultural "period" common lands held their fitting place; and when that stalwart yeoman's son, Bishop Latimer, in preaching before the Court, vehemently denounced enclosures, he represented a venerable national feeling in favour of the inalienable heritage of the poor; and his agricultural dilemma, "How then will you dung your fallows?" bespoke the practical farmer of the day. Yet the "period" of *common lands* has rightly been brought to an end; and that agricultural epoch which may be called "the period of irrigation," will perhaps never dawn upon this land, until *common waters* are dealt with in a similar spirit, existing rights and powers of administration not being destroyed but vested anew. In what men, or what body of men, the control of the waters of a district is vested, is in itself a matter of perfect indifference to progressive Agriculture so long as that control be efficient, and limited by certain safeguards. The chief requirement of an improver is to know clearly beforehand what he may use, and what he must pay for its use; and his worst foe is the dog in the manger, who will not even give a premonitory snarl or snap till plans have been matured and expenses incurred. Although the alternative is not a real one, it may be affirmed that a proprietor might be better off if stripped of his common-rights, but enabled to buy water at an easy rate, than he would be when possessed of vested rights, in the days of jealousy and disorganisation.

One principle of Italian legislation deserves special notice. The Code of Sardinia, Article 602, directs that "In case of dispute between proprietors, the tribunals, in deciding, ought to aim at reconciling the respective interests of the parties in the manner most just and equitable, having due regard to the rights of property, *to the advantage of agriculture, and to the special uses to which the water may be destined.*" Both in framing and in interpreting a law an authority may, from laudable motives, take its stand on different special points of view. For instance, in providing for education, the legislative body (often composed chiefly of teachers and examiners) may either select such subjects as are best adapted for an examination, and form the best criterion for discriminating between the ability of the candidates, or else it may adopt such a scheme as may best discipline and inform the mind: the former being the more professional, the latter the more philosophical, aim.

In like manner the maker or interpreter of law may be either bent on laying down such a broad rule that it may be easy, under any circumstances, to distinguish the case of A. from that of B., and, indeed, to foresee how the sentence will go; or else his chief aim may be to secure to each man that which is equitable, and guard the path of social progress though at the risk of intro-

ducing some fine-drawn distinctions. In our future course of action in England, it is to be hoped that "the advantage of agriculture and the special uses to which water may be destined" will, at least, not be overlooked when the laws which regulate our supplies of water are under consideration.

XII.—*Statistics of Live-Stock for Consumption in the Metropolis.*

By ROBERT HERBERT.

NOTWITHSTANDING that much distress arising from the cotton famine has continued to prevail in the manufacturing districts, and that the metropolitan market has been somewhat heavily supplied with beasts, the beef-trade, during the last six months of the past year, has shown signs of activity, and, with some few exceptions, prices have been well supported. The great abundance of food in the leading grazing districts, compared with some former seasons, has materially assisted the graziers. The bullock supplies exhibited in the period indicated have come to hand in full average condition, and for the most part they have "died" remarkably well. With respect to the sheep disposed of, however, we cannot report so favourably. The Downs, half-breds, Leicesters, and Kents have, we admit, been quite equal in weight and quality to those of most previous corresponding periods; but at least a moiety of the aggregate supplies have appeared in very middling condition, although the total losses from disease, in 1862, did not exceed an average, excepting in Wiltshire and the adjoining counties, where the smallpox, which was evidently introduced into this country either from Germany or Holland, occasioned serious losses. Lambs, though in good supply, sold at high rates until quite the close of the season; but calves and pigs were not much in demand.

The following return shows the supplies of each kind of stock exhibited in the last six months of the last ten years:—

Total Supplies of Stock Exhibited.

Year.	Beasts.	Cows.	Sheep and Lambs.	Calves.	Pigs.
1853	149,008	3191	860,800	17,058	15,284
1854	136,216	3157	853,020	16,490	19,531
1855	133,577	3185	751,818	14,810	22,350
1856	138,309	2864	689,444	14,280	18,733
1857	137,915	2948	701,414	15,006	14,992
1858	147,118	3137	746,839	15,186	19,441
1859	143,198	3030	808,334	12,277	16,130
1860	145,420	3015	762,740	15,766	15,470
1861	149,750	3187	774,260	12,441	20,116
1862	159,450	3148	759,671	12,579	18,220

This comparison shows some remarkable results. Although the population of London has, according to the last census, increased in ten years from 2,362,236 to 2,803,034, we find that an increase of only about 10,000 more beasts were exhibited in the last half of 1862 than in 1853; whilst the number of sheep has decreased by 101,129 head, even though in 1862 we received 37,843 beasts and 178,554 sheep, together with 12,279 lambs, from abroad. The number of calves gradually declined from 17,058 to 12,579 head; but it may be observed that, included in the latter number, were 11,436 from the Continent. It follows, therefore, that the introduction of foreign calves, duty free, has almost wholly destroyed the English calf-trade in this market. Possibly less stock has been purchased in London for country consumption; but since the arrivals of slaughtered meat up to Newgate and Leadenhall Markets have evidently not kept pace with the increased population, the total supply must have fallen off. No wonder, therefore, that prices have kept up, and that store animals, especially of a first-class character, should have realised very high rates. In order to show the progressive rise in the quotations, we direct attention to the annexed table of prices realized for beasts and sheep in the last six months of the fifteen years ending with 1862:—

Average Prices of Beef and Mutton.

Per 8 lbs. to sink the Offal.

BEEF.

	1848.	1849.	1850.	1851.	1852.
	s. d.	s. d.	s. d.	s. d.	s. d.
Inferior	3 0	3 0	2 8	2 8	2 4
Middling	3 8	3 8	3 4	3 6	3 4
Prime	4 0	4 2	4 0	3 10	3 10

	1853.	1854.	1855.	1856.	1857.
	s. d.	s. d.	s. d.	s. d.	s. d.
Inferior	2 8	3 2	3 4	2 10	2 10
Middling	3 8	4 0	4 2	4 0	3 10
Prime	4 10	5 0	5 2	5 2	4 10

	1858.	1859.	1860.	1861.	1862.
	s. d.	s. d.	s. d.	s. d.	s. d.
Inferior	2 10	2 10	2 8	3 0	3 2
Middling	4 0	4 0	4 0	4 0	4 0
Prime	5 2	5 2	5 4	5 0	4 10

MUTTON.

	1848.	1849.	1850.	1851.	1852.
	<i>s. d.</i>	<i>s. d.</i>	<i>s. d.</i>	<i>s. d.</i>	<i>s. d.</i>
Inferior	3 8	3 4	2 10	2 8	2 10
Middling	4 4	3 10	3 4	3 2	3 10
Prime	4 10	4 4	4 2	4 0	4 8

	1853.	1854.	1855.	1856.	1857.
	<i>s. d.</i>	<i>s. d.</i>	<i>s. d.</i>	<i>s. d.</i>	<i>s. d.</i>
Inferior	2 10	3 2	3 6	3 6	3 0
Middling	4 0	4 0	4 2	4 4	4 2
Prime	5 2	5 0	5 0	5 4	5 4

	1858.	1859.	1860.	1861.	1862.
	<i>s. d.</i>	<i>s. d.</i>	<i>s. d.</i>	<i>s. d.</i>	<i>s. d.</i>
Inferior	2 10	3 0	3 2	3 2	3 8
Middling	4 0	4 2	4 6	4 6	4 8
Prime	5 2	5 2	5 10	5 8	5 6

In the first five years given above it will be seen that beef was unusually low in price in this country, and that the rise in the value of the best Scots since 1852 has been 1½*d.* per lb. In 1858, 1859, 1860, and 1861 the advance was even greater, arising in some measure from the wretchedly poor quality of the stock brought forward. Nearly the same remarks may be applied to sheep, the best of which can now scarcely be obtained under 6*s.* per 8 lbs. In 1851 the average value of the best Downs was only 4*s.* per 8 lbs.

The following tables, which have been compiled to show the sources of these supplies, clearly indicate the progress made in breeding and feeding in various districts in England, as well as in Ireland and Scotland:—

District Bullock Arrivals.

Year.	Northern Districts.	Eastern Districts.	Other parts of England.	Scotland.	Ireland.
1853	54,650	8650	15,500	4728	7,412
1854	55,200	3400	16,500	2817	7,000
1855	52,800	3000	11,050	2993	8,200
1856	60,760	..	20,700	2734	11,000
1857	81,600	7000	15,370	1836	12,000
1858	66,260	6970	13,820	2674	13,760
1859	64,470	3600	23,220	4640	10,544
1860	66,140	9500	20,500	1151	7,852
1861	71,450	2500	9,700	4586	14,340
1862	74,570	5050	19,620	3307	14,820

Whilst the supplies drawn from Lincolnshire, Leicestershire, and Northamptonshire, and some other parts of England, as well as those from Ireland, have gradually increased, those from Norfolk, Suffolk, Essex, Cambridgeshire, and Scotland have, in the past year, fallen off. This comparison, however, as regards Norfolk and the adjacent counties, does not refer to what is termed the "season." Our impression is, that quite as large a number of really prime beasts were fattened in Norfolk in 1862 as in most previous years. The increase in the receipts from Ireland in 1861 and 1862 may be chiefly attributed to the limited demand for butcher's-meat in the manufacturing districts, which led many of the Irish graziers to forward their stock direct to the metropolis. A few really good crosses have been received from Ireland; but the general quality of the stock has certainly not improved.

The supplies of foreign stock imported in the last six months of last year were a fair average. The annexed return shows the quarters from whence they were derived:—

Imports of Foreign Stock into London.

From	Beasts.	Sheep.	Lambs.	Calves.	Pigs.
Amsterdam	67	7,946	..	..	..
Antwerp .. ..	..	..	..	492	2
Boulogne .. ..	..	158	..	..	..
Bremen	1,499	45	..	22	..
Calais .. ..	..	..	..	61	..
Carril	520	..	..	..	..
Corunna	422	..	..	..	..
Dordt	2,926	15,429	4,519	66	704
Guernsey	4	..	..	..	..
Hamburg	1,061	27,496	..	..	1,001
Harlingen	2,568	28,244	1,159	1,231	10,205
Havre	9	..	..	..	..
Medemblik	492	23,810	..	20	..
Nien Diep	136	3,124	3	17	..
Oporto	616	..	..	..	..
Ostend	41	..	..	174	..
Rotterdam	5,515	54,146	3,603	9,348	320
Stettin	170	900	126	..	..
Tonning	20,019	17,254	2,869	3	..
Varel	682	2	..	1	..
Vigo	1,096	..	..	1	..
	37,843	178,554	12,279	11,436	12,232

According to the returns issued by the Board of Trade, the imports of foreign stock into the United Kingdom in the last six months of the following years were—

		Beasts.	Sheep and Lambs.	Calves.	Pigs.
1861	.. ..	59,049	266,249	19,715	25,919
1860	.. ..	59,817	243,804	19,594	21,510
1859	.. ..	48,841	192,750	14,764	9,965
1858	.. ..	54,348	163,840	19,494	11,315
1857	.. ..	51,155	147,096	18,273	10,172
1856	.. ..	51,418	131,472	16,179	9,707
1855	.. ..	55,222	142,712	14,905	11,762
1854	.. ..	65,881	145,406	16,355	10,440

It will be seen that the largest shipping-ports on the Continent are Dordt, Hamburg, Harlingen, Medemblik, Rotterdam, and Tønning, from which latter we received upwards of 20,000 head of beasts. The exports from Hamburg have consisted of stock fed in Germany. The sheep have shown some little improvement in quality; but they have been disposed of at very low prices—viz., from 18s. to 30s. each. The Dutch beasts have come to hand in middling condition; but some of those from Tønning—which have been crossed with some of our shorthorns—have realised fair quotations. On the whole, the weight of meat imported has rather increased.

Although about 20,000 casks of tallow were held back by the Russians, at St. Petersburg, at the close of the season, evidently for the purpose of controlling the market here, the tallow-trade has ruled heavy, and prices have had a drooping tendency. Rough fat has consequently declined to 2s. 3½d. per 8 lbs.; nevertheless the present low value of the article has had but little influence upon the prices of meat. In periods of limited consumption a depression in rough fat has been generally followed by a smart decline in the quotations realised for both beasts and sheep.

Within the last few months much discussion has prevailed amongst the agricultural body in reference to the present system of breeding stock for general consumption. On the one hand, those gentlemen who have aimed at early maturity and prime quality have contended that, had it not been for the extension of the mixing of breeds by means of crossing, stock must have become unusually scarce and dear; and on the other, that much danger may be apprehended from a wholesale destruction of pure animals. It is generally conceded that *first* crosses have for the most part turned out remarkably well for the butcher; but the degeneracy and loss of stamina which is remarked in various parts of England and Scotland are often attributed to the effects of a second and third crossing. In order to understand how far the system has progressed, we have been at considerable

pains to ascertain the percentage of each breed of beasts exhibited in the metropolitan market during the past year. The result of our investigations is as follows :—

Percentage of Beasts shown in the Metropolitan Market in 1862.

	Percentage.
Shorthorns	34·50
Herefords	9·25
Devons	5·00
Longhorns	1·00
Crosses, English and Scotch	19·00
Highlanders	1·50
Polled Scots	3·75
Ayrshire	0·25
Irish crosses	8·25
Welsh runts	1·75
Irish	7·00
Bremen, Tanning, Dutch, and German ..	8·50
Spanish and Portuguese	0·25
	<hr/> 100·00

A comparison of the percentage given above with that of 1858 will materially assist us in arriving at a correct knowledge of the progress of each breed in that period. In that year it was as follows :—

Percentage of Beasts shown in 1858.

	Percentage.
Shorthorns	33·00
Herefords	9·25
Devons	5·00
Longhorns	1·00
Crosses	16·00
Highlanders	2·00
Polled Scots	4·00
Ayrshire	0·25
Irish crosses	8·00
Welsh runts	1·50
Irish	9·00
Bremen, Tanning, Dutch, and German ..	9·50
Spanish and Portuguese	1·50
	<hr/> 100·00

The above comparative statement shows that, whilst the Herefords and Devons have remained about stationary, the shorthorns and crosses have largely increased. The pure Scotch breeds have somewhat declined. In 1838 the shorthorns stood at 30·00; the Herefords, 13·00; the Devons, 11·00; English crosses, 13·00; Scotch crosses, 1·50; and Welsh runts, 10·00. The latter breed somewhat recovered themselves in 1862; but it is clear that early maturity from extensive crossing has become very general. Clearly, however, we *must* have pure blood to fall

212 *Statistics of Live Stock for Consumption in the Metropolis.*

back upon; and more than ordinary care is now required to secure this important point, otherwise the country may present few other than mongrel animals of comparatively little value either to the butchers or the breeder.

So mixed have become the races of sheep, that it is a matter of no ordinary difficulty accurately to define the percentage of each breed exhibited in the past year. The annexed statement, however, is a fair reflex of each breed:—

Sheep shown in the Metropolitan Market in 1862.

	Percentage.
Lincolns	22·00
Leicesters	22·50
South Downs and Hampshire Downs ..	15·00
Crosses, including foreign	21·00
Gloucesters and Gloucester Downs ..	7·00
Kents	3·00
Scotch	1·00
Irish	2·00
Dutch	3·50
German	2·00
Danish	1·00
	<hr/> 100·00

In 1858 the percentage was as follows:—

	Percentage.
Lincolns	27·00
Leicesters	25·00
South Downs and Hampshire Downs ..	10·00
Crosses	15·25
Gloucesters and Gloucester Downs ..	8·00
Kents	5·00
Scotch	1·00
Irish	3·00
Dutch	4·50
German	1·00
Spanish	0·25
	<hr/> 100·00

Here we find a great falling off in Lincolns and Leicesters, but a very large increase in the crosses. The Kentish sheep have given way before the latter; and it may be a matter of doubt in some quarters whether the pure Leicesters have not fallen in a greater ratio than is shown above. However, one thing is very clear, viz. that crossing is rapidly becoming general, and that eventually there may be a great scarcity of pure stock in the country. In 1838 the percentage for Lincolns was as high as 31·00, and for Leicesters 29·00, whilst crosses figured for only 13·00. Now, including the foreign imports, they amount to

21'00. These statistics will, we trust, tend to remove the doubts which have existed in the minds of many persons on a question of so much importance as the production of food for general consumption.

4, Argyle Square, St. Pancras, London.

XIII.—*Some Account of Brittany Cows.* Taken from Notices by
M. JAMET, of Rennes. By P. H. FRERE.

SINCE this race has been examined with interest in the large classes exhibited at Battersea, and not only have specimens been purchased by wealthy proprietors as a matter of curiosity, but also dairies set up by those who live by the sale of milk in the environs of London, it may be worth while to inquire into the estimation in which it is held in its own country.

Two notices, written by M. Jamet for the '*Journal d'Agriculture Pratique*,' point out how far that national organ of scientific agriculture justifies or qualifies provincial predilections. We will, then, borrow from that source such remarks on this subject as seem most adapted to the English reader.

This race appears to be valued not so much for the quantity of milk which it yields as for the quantity and quality of the butter. That it was not highly esteemed in old time is evident from early efforts made to improve it by a cross; recently it has been crossed successfully with the shorthorn, and to no good effect by the Ayrshire bull. It is emphatically the poor man's cow, and it may be well to consider what that title implies. As to colour, the black and white race which prevails in Morbihan now mostly sets the fashion, and is the common representative of the breed; but the red and white stock of Cornouaille have the same origin and type, and the colour is occasionally interchanged.

The merit chiefly insisted upon is the quality, colour, and especially the *flavour* of the butter. M. Jamet asserts that this, which is a nutty flavour, is quite independent of the herbage or fodder consumed by the animal, and that it is retained in the produce of crossbred stock to the third or fourth cross. The existence of this peculiar flavour seems to be generally admitted, but some refer it to a peculiarity in the soil affecting its produce, even when such keep as clover or cabbages is substituted for the common pasturage.

The author, travelling with a strong advocate of this latter theory in the adjacent province of La Vendée, espied some Brittany cows on the lawn of the friend they were about to visit,

and having promised the sceptic some butter of the true Brittany flavour, was acknowledged to have fulfilled his promise—" *La question était nettement résolue.*"

The butter, then, is much esteemed at home (at Rennes, Ayrshire butter would not sell), and much of it is exported to England. It would, therefore, seem that it is a mistake to sell the produce of these cows as milk, particularly near London, where food of choice quality and delicate flavour is so highly prized.

Next as to cross-breeding. Both the states of Brittany in old times, and the present provincial administration under the Empire, have voted grants of public money for the object of improving their breed of cattle. So long ago as 1760, on the suggestion of the Bishop of St. Pol de Leon, 45 bulls were bought in La Vendée of the Bocage breed. In the more remote parts of the province the influence of this importation was only indirectly felt, but it has left permanent traces in the grey tint which encircles the eye and tips the muzzle of many cows. Other French breeds have been tried for crossing with no great success, though without diminishing the value of the produce. From Great Britain, Ayrshire bulls have been imported by the préfet of the department Ille-et-Vilaine: a mistake, in M. Jamet's opinion, because that breed has the same weak points as the native race,—a narrow chest, defective hind-quarter, and, above all, because the milk of Ayrshires, though of fair quality for cheese-making, is deficient in butter. It would seem, however, that the last importations from Scotland were not favourable specimens.

The cross with the Ayrshire, then, is not to be recommended. To a cross with the Jersey breed objections are raised on the score of their very defective frame (an evil considerably modified of late) and of the rich food which they require.

On the other hand, crossing with a shorthorn is considered a decided success. "After a trial of twenty years at Grand Jôuan, it is found that the half-bred Durham and Brittany has a much better shape, and gives more milk in proportion to the live weight and to the food consumed, than the pure native race. Their earlier maturity and increase in size add to the value of this cross."

The dairy of the model farm at Trois Croix has been quite remodelled by the use of shorthorn bulls, the yield of butter not being impaired, since 9½ quarts here produce 1 lb. of butter; whilst with the pure breed, on an average, nearly 10 quarts (9·84) are required.

The Breton breed, when pure, may be crossed three or four times. In the case of the ordinary cows of the country, it will be well to stop at the second cross, because, having no fixity of

type, they more readily receive the impress of the new influence. In this manner the shape may be improved without prejudice to the produce of butter.

The little Brittany cow has never been highly esteemed at home. Even now, a leading farmer has been known to be unwilling to be *seen* buying one. How far, then, is the preference shown to them by some amateurs justifiable? M. Jamet's answer is as follows.

"The little Morbihan (Brittany) cow is of tiny size; her head is charming; her fine legs and slim feet add to the delicacy of her shape, which, at the first glance is very attractive; but in the eyes of the real judge of stock this impression is overcome by the defects of the body. In proportion to her size and weight, the belly is enormous; the size and depth of the flank exaggerated. If you add to this a narrow chest and a light hind-quarter, you have a true portrait of a Brittany cow, which may take with the crowd but cannot satisfy the enlightened breeder.

"In fact, the shape of this little creature speaks of itself to the eye of intelligence; it cannot be an economical producer. I know that she has the reputation of living upon little, but she does not deserve it, because *proportionately* she eats a great deal. She grazes all day on the waste; her delicate lips enable her to crop the short and nutritious herbage which clothes the soil between the stems of fern and rushes. In one word, if she eats so little, why is her belly so distended as it is?

"Remove her to rich land and she will take in much food, but the yield of milk never increases, and as she fattens her milk will dry up.

"The Brittany cow has a right to her place on the sandy wastes (*landes*). She yields a produce, small though it be, where other breeds could not live. It would be folly there to introduce a new breed or to transform the existing one; but it is absurd to transport her to fields long under cultivation where keep is good, for her produce does not increase with the value of her food.

"Be it, however, admitted that rich proprietors are not to blame for keeping a few Brittany cows for the use of their establishment, as the butter is delicious.

"It has been asserted that the Morbihan cow is the poor man's cow. A poor family may keep one, after a fashion, on commons and the roadsides; but, permit me to say that this poor man's cow is but a *poor cow* in a better berth."

After commenting on the inexpediency of giving prizes for the pure breed, M. Jamet concludes thus—

"The Morbihan cow gives little milk, but of an agreeable taste and containing much butter; its taste and quality are

retained even after the breed has been crossed several times, as may be clearly seen in the district of Rennes. This fixed character and property of the race arises probably from its antiquity.

XIV.—*Cultivation of Carrots and Cabbages for the Feeding of Stock.* By C. LAWRENCE.

How does it happen that these valuable foods for stock are so rarely met with on ordinary farms?

Is it that their feeding qualities, as compared with other roots in common cultivation, are imperfectly known?

Is it that the comparative produce of food per acre has been under-estimated? or

Is it from misapprehension as to the comparative expense and trouble of raising them, which may be attributable to defective preparation and subsequent management?

I had contemplated an illustration of our second question by giving a table of analyses of carrots, cabbage, mangolds, and swedes, compiled from those of various chemists which have been published in our Journal, and other works of authority, under the several heads of "Nitrogenised organic substances capable of producing flesh;" "Substances fitted for the support of animal heat and the formation of fat;" "Inorganic matters (ash)," &c.; but every year's experience teaches us, that however valuable and useful may be the indications afforded by the *chemical* laboratory, there exist occult operations in the *animal* laboratory that produce results which tend to discourage too close a reliance on such analyses. Moreover, all these roots yield very various analyses at different stages of their growth and maturity, and no comparative analyses that had not been made of each kind in a perfect state of maturity can be depended on. There are some very valuable observations on the first question under our consideration in a pamphlet recently published by Dr. Voelcker, being a report by him, in the 'Journal of the Bath and West of England Society,' of the result of investigations which he had been requested to make "on the scouring lands of central Somerset." Feeders of stock, who may be free from the pest of scouring land, may pass over this article as inapplicable to their individual cases; but I commend to the attention of all stock-masters an attentive perusal of at least the observations commencing at page 16 of the pamphlet.

We have hitherto placed, it seems, too much reliance on the amount of the nitrogen disclosed by analyses in the various roots

and green crops; while Dr. Voelcker's recent investigations, reported in the paper referred to, tend to show that a large proportion of nitrogen in such crops is rather an indication of their immaturity than of their feeding value. The Doctor observes on this point:—

“Not many years ago a high percentage of nitrogen in hay, turnips, mangolds, and other kinds of agricultural produce, was regarded as a proof of their superior nutritive value; but a thorough investigation, which I undertook on account of the frequent discrepancies in the calculated theoretic nutritive value of various articles of food, and the value assigned to them by practical men, has shown me that the higher proportion of nitrogen in one of two samples of hay, turnips, mangolds, &c., by no means indicates a higher feeding value, but the very reverse. I have been actively engaged for more than three years with an inquiry into the changes which roots undergo in their various stages of growth, and especially when they approach maturity.”

I know that Dr. Voelcker's opinion is that the practical feeding value of different foods depends more on the relative amount of sugar than of nitrogenised matters. In his very instructive pamphlet ‘On the Chemistry of Food,’ he thus writes of cabbage:—

“Indeed, no kind of *green* food cultivated on a large scale in the field contains so much nutritious matter as cabbage. Being much more nutritious, weight for weight, than turnips, and at the same time very succulent, cabbages form a valuable food for milk cows. Cattle are very fond of cabbage, and dairy cows fed on it and some hay produce much and rich milk, and the butter made from the *latter* is free from the disagreeable flavour which it always has when cows are fed upon turnips. Cabbages, for this reason, are a valuable substitute for turnips, and deserve to be more extensively cultivated in England than they are at present.”

Dr. Voelcker states, in a letter to me, that “one ton of dry matter of carrots is worth more than a ton of the dry matter of cabbages.”

Having disposed of our first inquiry, the second, as to the comparative produce of food per acre, will receive various estimates in different parts of England. Every farm will, however, in the course of three or four crops, show what is its average acreable produce of cabbages, carrots, mangolds, and turnips. Dr. Voelcker has observed, in reference to the farm attached to our Agricultural College, which my farm joins, “the calcareous soil in the neighbourhood of Cirencester, on the whole, is not favourable to the growth of these roots (parsneps and carrots), it being in most instances too stony and shallow.” Yet I have grown 32 tons of the white Belgian carrot, the roots weighed without the tops, and the tops, weighed separately, amounted to 7 tons,—about 35 tons of mangolds, exclusive of leaves, and 24 tons of swedes per acre. These crops were on fields in which we could plough seven or eight inches without meeting any

obstruction from stones. I have never weighed a crop of cabbages; but, from having frequently weighed a given number of plants at maturity, I am able to estimate about an *average* yield per acre as 30 tons. On similar land, under the same treatment, the *average* yield of swedes would be about 18 tons; and of mangolds about 22 tons. We have weighed many heads of cabbages in a crop weighing 26 lbs. and upwards; and I have seen specimens grown in the neighbourhood which, I was informed, weighed 36 lbs.; but under the treatment I have described I estimate 14 or 15 lbs. each as an average weight throughout the crop.

Considering the comparative ease with which a cabbage-crop is kept clean, we do not consider the cost of the cultivation of it to exceed that of mangolds and swedes. The cost of labour attending the carrot-crop, when raised, will considerably exceed that required in maturing those crops; but it must be borne in mind that the tops of the carrots, when the roots are taken up, greatly exceed in weight and nutritive value the tops of mangolds or of swedes at the season at which the latter are usually heaped or fed off on the ground.

Mode of Cultivation.—First, as to carrots. Under a strong impression of the feeding value of these roots, many years antecedent to the publications to which I have referred, I have for a long period given much attention to the treatment of this root as well as cabbage, and I have devoted to them about one-sixth of my root-quarter. Assuming the selection of good clean seed, we allow 5 or 6 lbs. per acre. For some years the great difficulty we had to encounter was the rapid growth of the ordinary annual weeds of the field, as compared with the slow vegetation of the carrot-seed; the consequent continual labour and cost in keeping the rows clean,—an expense which has led many persons to abandon the crop. Another difficulty was the peculiar adhesive nature of the seed, in consequence of which the patchy and irregular plant of carrots in the field is matter of common observation. We have got over the latter difficulty by mixing a moderate quantity of dry ashes with the seed, and rubbing them together till the seed is well separated. We then put the entire quantity for the acreage to be sown, thus separated, in a heap, and moisten it with a watering-pot, turning it over until the whole is damp, but not wet. This should be done about ten days before sowing the seed, and the heap should be turned over two or three times during that interval, until the commencement of vegetation is perceptible. Before sowing, sufficient dry ashes should be scattered amongst the heap to insure its running freely through the drill.

Carrot-seed is commonly sown too early: it will not vegetate

freely under a given temperature of the earth, prior to which the seeds of the common annual weeds will have made a vigorous start. We have successfully encountered this difficulty by harrowing down the land appropriated for carrots about a fortnight before we propose to sow the seed: indeed, just before we begin to prepare the seed. During this time the seeds of the annual weeds brought to the surface by the harrowing will generally have vegetated, and the carrot-seed will have just sprouted. A second light-harrowing will upset the former, and the carrot-seed, thus started, will get sufficiently ahead of the weeds to render the destruction of any aftergrowth of them an easy matter. We drill the seed in rows 18 inches apart. As soon as the rows are distinctly visible we flat-hoe between the rows on a dry day, and use the horse-hoe when the plants are about 3 inches above the ground.

Carrots are so difficult to single with the hoe that the attempt does not answer. Our men cut them out 6 inches apart with a sharp hoe, leaving two or three in a bunch, at the cost of 5s. an acre; boys or girls, holding down with one hand the carrot to be left, drawing the rest with the other hand, at 3s. 6d. per acre. It must be seen that the men cut the plants off under the crowns, otherwise they will shoot again, and injure the crop by over-crowding. The carrots will be left about 7 inches apart, and when about 6 inches high, will require a second hoeing. We prepare the land for carrots and cabbages in the same way as for the other root-crops, viz., by manuring immediately after harvest, and giving as deep a ploughing as the character of the soil admits of to lie during the winter. By these means we never fail in securing a perfectly regular plant, and covering the ground with a very valuable crop. We consume them mainly in feeding the horses during the winter and spring months until vetches are ready and the fatting pigs. About one peck of pulped or sliced carrots, mixed with the chaff and corn at each feed, keeps the horses in good health and condition.

The lifting a good crop of carrots without breaking them requires careful management. We use strong forks made for the purpose attached to a common spade-handle, having two prongs 10 inches long, the space between them being $2\frac{1}{2}$ inches at the points, and $1\frac{1}{2}$ inch at the base, the iron on which they are formed extending 3 inches to the right of the handle, to enable the men to press the forks down into the ground with the foot. An iron plate should extend at least a foot up each side of the handle. The strain on the attachment of the fork to the handle is great in raising a long carrot. The best mode of raising the carrots is for each man to be followed by a boy or girl; the man

raises the roots, and the attendant draws them by the top and lays them in regular rows. The cost of this varies considerably. A moderate crop, not running deep, in an open soil, can be raised at 15s. per acre; while a large crop, having long roots in a deep tenacious soil, will cost 30s. to raise carefully. When the men have got considerably in advance, women follow to top the roots. This requires careful supervision, or they will make a proper mess of it, and have roots and tops scattered in all directions, with dirt intermixed, involving much waste. When one row has been pulled, two rows on either side should be placed on the site of that row, in order to leave room for the carts without crushing root or top. The roots should be laid together, the tops lying right and left of the roots. The cutters will thus drop the tops in one heap and the roots on another; leaving in line alternate heaps of roots and tops, which can be carted away separately. The tops—very nutritious food and relished by all animals—are thus kept free from dirt. A shilling per ton of roots is a proximate cost of raising the roots, topping, and placing them as described.

Cabbage.—Assuming 4 acres of ground to be set apart for this crop, I recommend planting 3 acres with cabbage, and 1 acre with savoy, which do better than cabbage late in the winter. The seedsmen reckon 1 lb. of seed to produce plants for an acre. We sow the large drumhead variety; and taking care to procure the best of seed, we find practically, that with proper care in sowing and after management, 1 lb. produces plants sufficient for 3 acres of ground. We sow $\frac{1}{2}$ lb. of the large savoy seed. Prepare about 20 perches of ground, in July, sheltered from the north and east, and, while moist, sow the cabbage-seed in drills 12 inches apart *thinly*, the last week in the month, or not later than the first week in August. When the plants are above ground, keep them clean. By the middle of October draw the plants, and reset them across the same ground, laid in shallow trenches, 3 or 4 inches from each other in the row, the trenches 9 inches apart. This plan forms strong short-stemmed plants, with good fibrous roots, which grow away as soon as planted out the next season; whereas, if left in the seedbed, they get drawn up with long stems and less perfect roots, and are weeks recovering their removal in the spring. Ridge up the land as for mangolds or swedes, but let the ridges be 3 feet apart; and about the middle of April plant out half the cabbage plot, setting the plants 3 feet apart in the rows. The rest of the ground may be planted about one month later.

The savoy-seed may be sown in March, and the plants set out in the field the end of May or early in June.

As methodical arrangement in matters of this kind not only produces results agreeable to the eye, but materially diminishes the cost of labour, I extract from my 'Handy Book for Young Farmers' our practice to insure accuracy in setting out the plants to facilitate hoeing, &c.

"This is accomplished by the use of a line attached to a stick just 3 feet long, at each end of the line, which is laid across the ridges. As each row of plants has been set, the workers at each end of the line move it forward just the length of the stick to which it is attached. The plants should be loosened in their seed-bed before drawing by a small hand-fork, to prevent damage to the young root by pulling them from the firm ground, stowed in baskets by boys or girls, and carried to the ground, and laid down by them on the ridges just before the planters. The planting may be done by women, each of whom should be furnished with a trowel to open the ground freely on setting the plants. This is material when the land is moist, as it should be for the purpose, as the roots then strike out freely; the common setting pin being turned round forms a puddled hole, which obstructs the striking out of the young roots. The two outside setters may be men to manage the line. We have set out in this way 10,410 plants on upwards of two acres of ground between the hours of 8 and 12 in the morning, by four men, 6 women, and 2 boys to place the plants."

The purpose to which, more especially, we devote the crop of cabbage is to feed the wether lambs after removing them from the young clovers at the end of October, and before they get on the swedes at mid-winter. We fold the lambs on the cabbages as they stand, without any cutting; they eat up not only the cabbage without any waste, but make their way into the stems. They are most useful for all stock during the autumn months, when clovers are being ploughed up and the grass grounds are dried up.

Cirencester, 1st October, 1862.

XV.—*Experiments on Transplanting Mangold.* By W. GURDON.

IN the spring of 1858 I was thus led to make an experiment in transplanting mangold wurtzel. In order to test the goodness of some yellow globe-seed, before sowing the bulk, I had ordered some to be placed in a box, with 4 or 5 inches of earth, and raised in a striking-house. When I offered this boxful of plants to a small farmer in the parish he declined them, saying that they were useless, as transplanted mangold were always of bad quality; to use his own expression, "they were *rooty and fangy*."

It occurred to me, from having some experience of root pruning

in gardening, that the cause of this "rooty and fangy" condition was the breaking of the taproot, by *drawing the plants*. To test the correctness of my suspicions I ordered a portion of the plants to be shaken out of the box, by turning it topsy-turvy; giving at the same time strict orders that, as far as possible, every rootlet should be carefully preserved.

Under these directions a row was set in the garden. The plants were placed at a foot apart in the row, having an onion-bed on one side, and a row of brocolis on the other. The plants were at this time about 4 inches long, and were put in with a small planting-trowel. The ground had been deeply trenched, and brought within the garden a year or two before, and was a fine rich brick-earth. The only attention they received was, that about a month after, ten or twelve plants which had been eaten off by slugs, were filled up from the same box (probably as late as the second week in June), and one very moderate hoeing was given them by myself. The result was as follows:—

Length of row	..	..	..	..	..	..	95 feet.
Number of roots taken up	..	..	..	..	..	..	91
Weight of roots	..	..	..	..	..	..	629½ lbs.
Weight of tops	..	..	..	..	..	..	108½ "
The twenty heaviest	..	..	..	..	..	..	211 "
The twenty lightest	..	..	..	..	..	..	72 "
The fifty-one remaining	..	..	..	..	..	..	346½ "

A sample of these roots was taken to the Hadleigh Farmer's Club for inspection by the members, and was allowed to be of excellent quality. It must be observed, however, that although the *quantity* proved quite as satisfactory as the *quality*, the object of the experiment was for quality only, and not for quantity; and, as a strong opinion seemed to be entertained that the latter was to be attributed to the spot where the experiment was tried, I determined to repeat the experiment in the field in the following year. Accordingly one ridge was left unsown in a 9-acre field of yellow globe, and planted about the third week in May, as soon as the sown plants were well up. The number of plants was 398, and the number of roots taken up on the 5th of November, 1859, was the same, no root missing. They were set at 13 inches from plant to plant, and 30 inches from row to row. Weight of roots, without tops, 168 stones 13 lbs.—not quite 6 lbs. per root; or at the rate of more than 42 tons per acre. These were inspected, while growing, by several members of the Club, and allowed to be all that could be wished.

As two acres in the same field were set out to compete for the Club prize, I had the opportunity of comparing the produce sown with that transplanted, which was in favour of the latter, the Club

having awarded me the first prize for 40 tons 17 cwts. 16 lbs. per acre, without the tops.

In 1860 I planted two acres; the plants, however, were not properly raised. It happened also that the season was very wet, and the land undrained; so that no attempt was made to weigh the produce separately. Some, however, that were put in before the great fall of rain, succeeded very well.

The spring and early summer of 1861 were as remarkable here for dryness as 1860 had been for wetness, scarcely any rain having fallen here from the middle of April to the middle of June. The consequence of this was a failure of the general crop of mangold, there not being moisture sufficient to make the seeds vegetate. With the transplanted, however, the result was far otherwise. One row was reserved unsown, as in 1859, and was not planted, owing to the continued drought, till the very end of May. On this occasion they were set at 15 inches apart, and 27 inches from row to row. Of 625 plants put in, three were ploughed out in making water-furrows; and on the 31st of October, 620 roots were taken up, weighing 318 stones 6 lbs; or, allowing for the three ploughed out on the average of the rest, just 50 tons per acre. Owing to the failure of plant from the drought, the crop in this neighbourhood was generally deficient.

The crop of transplanted last year was comparatively inferior; that is, it was not so much better than the sown as in other years. It was planted by itself, on 30 rods of an old car (or copse), from which ash-trees and alder-stubs had just been removed, and the only manure used was a small quantity of artificial. The produce was 2471 roots, weighing 6 tons 7½ cwts., or at the rate of about 35½ tons per acre. This was about 2 tons more than the best two acres sown on my own farm, and about equal to the crop that took the first prize of the Hadleigh Club.

Such having been the results of growing mangold by transplanting, it may be asked, do I recommend that the whole crop on the farm should be grown in that way? My answer is ready; I do not recommend what I know I should experience great difficulty in carrying out. My own plan, to which transplanting is a valuable accompaniment, is to dibble the seed with a dibbling-wheel, invented for the purpose. Of these I have two, one 3 feet 9 inches, the other 4 feet 2 inches, in circumference; the first having three dibbles, and the second four. The dibbles, instead of being cone-shaped, resemble the small ends of so many wedges 3 inches broad, bent lengthways on the iron tire. The children in dropping are directed to scatter the seeds along the hole, by which means the plant which is left is not so likely to be disturbed in singling, and the singling is more easily performed.

By this means also the plants are at once set out, no space between two being less than a foot, or more than 18 inches. It will easily be perceived that the distances between the plants being thus regulated, if the filling up be carefully attended to at the proper time, almost every space may be filled in ordinary seasons.

As a large expenditure is generally made in preparing for this valuable crop, to ensure a heavy produce a regular plant is the chief desideratum. If a man could fill up no more than 500 a day, the produce might be worth from 10*s.* to 1*l.*

I ought to add that the dibble takes two rows, and consists of two wheels, which move on an axle, so as to adjust them to the width from row to row. It is guided by a T-shaped handle, the workman pushing it before him. There would be no difficulty in attaching these dibbling-wheels to the roller, whether the crop be sown on the flat or the ridge. If on the latter, a couple of iron ridge-rollers might be used; each roller, in shape like an hour-glass, covering one ridge, with its dibble to follow. The mangold used in all these experiments has been the yellow globe. Our late Chief Justice of Singapore, Sir Christopher Rawlinson, informed me that he had always raised his garden beet at Singapore by striking the seed, and then planting out.

In conclusion, I would observe that the seed-bed, the dibble, and the filling up by transplanting, are parts of one whole system. The seed-bed in the hands of a gardener is simple enough, as a matter of his ordinary calling. With the farmer it is otherwise. For his information, therefore, I may state that it is best formed of stable manure, turned over once or twice, so as to be well heated. It may then be laid about 2 feet deep, and 6 inches of loose striking-earth spread upon it. This should be formed of rotten turf, or roadside parings; decayed leaves, or other vegetable manure; the bottoms of dry ditches, with a good deal of silt, so as to form a loose compound, in which the seeds may root freely. The bed should be allowed a few days to settle and to warm the earth before the seed is sown. When the plants are removed from the bed, great care should be taken not to injure their roots. Girls' fingers are the best for separating the little plants, and laying them ready for the planter. The planting with me is done with a garden trowel; and, if done carefully, not more than 5 per cent. will require to be set a second time.

Brantham Court, 5th February, 1862.

XVI.—*On the Growth of Barley after a Grass-layer.*

By P. H. FRERE.

THE unpromising state of the wheat trade encourages me to report the result of an attempt to substitute the growth of barley for wheat on light sandy soils in four following seasons of very varied character. If, on such lands the barley crop can be made to bring in as large a money value as that of wheat, the farmer will be benefited by such a change, from his horse labour being better distributed, from his retaining a valuable autumn run for his ewe-flock, and, as I believe, from less demand being made on the soil by the crop. In all cases the land selected for this trial has been the very weakest portion of my heath land, black sand on chalk rubble, resembling Newmarket heath. On this land which is too light to carry any other layer than rye-grass, with an admixture of trefoil and Dutch clover for sheep-food, the worst part of the field has been left at wheat sowing time, manured and ploughed at leisure during winter, and sown with barley on the whole furrow in the spring, part of it having been folded, the rest having received straw manure—a ton or two less per acre than would have been applied to wheat.

I first tried this course in 1859, a very scorching year, with a wet harvest. Eight acres 3 roods then produced 36 quarters 5 bushels, of which 31 quarters were sold at 43s., and the tail was valued at 26s. The total value of the crop was 8l. 9s. per acre. The yield per acre, 31 bushels 3½ pecks. The adjoining 28 acres of barley grown after rape reaching up to a man's middle, which had been eaten off with sheep, produced 76 quarters 3 bushels, which besides being more thin had been damaged by rain in harvest, and was sold for 25s., 26s., and 28s. per quarter, realizing 102l. 7s. in all, or only 3l. 12s. per acre. In this season the whole barley crop from 102 acres amounted to 338 quarters, and realized 862l.; the highest price made, except on the trial piece, was 40s. per quarter. The wheat crop on 36 acres of heath land averaged 26½ bushels, and was sold at about two guineas per quarter, making 247l., or about 7l. per acre; its quality was inferior.

In the year 1860, 15½ acres of similar land treated in like manner gave 61½ quarters of head corn, sold at 40s. and at 38s., and 4½ quarters of tail valued at 30s.; 66 quarters in all, or 5 quarters 3½ bushels per acre, worth 8l. 4s. In this, a good season, heath barley after turnips on better land gave 5 quarters 2 bushels per acre of the same quality and value as the barley sown on a whole furrow. The entire barley crop, from 126 acres, yielded 644 quarters, and made 1189l. The wheat (25½ acres) grown on the better part of the trial field, yielded 29 bushels, sold at 52s. and 54s. per quarter, and made 9l. 10s. per acre. Thus the

wheat in this year of fair prices made 1*l.* 4*s.* more per acre than the barley, but much of this difference must be laid to the account of a somewhat better soil and larger manuring.

In 1861, 11 acres of land of the worst quality similarly treated yielded 68 quarters, or over 49 bushels per acre, which made nearly 120*l.*, or nearly 11*l.* per acre, selling for about 37*s.* and 36*s.* per quarter.* The heath turnip shift averaged 31 bushels. The whole barley shift, consisting of 125 acres, produced 640 quarters, sold for 1123*l.* In this year the heath-land wheat, 42½ acres, averaged only 24 bushels 3 pecks per acre, the early sown yielding 12 bushels per acre less than a late sown piece. It was sold at prices varying from 51*s.* to 58*s.* per quarter, and at these comparatively high rates made nearly 9*l.* per acre or 2*l.* less than the barley.

In 1862 the trial was renewed on 17 acres, which yielded 89½ quarters of head corn sold at 37*s.*, and 5 quarters of tail valued at 30*s.* The yield was therefore more than 5½ quarters, and the value more than 10*l.* per acre. Of the adjoining wheat, 10 acres only has been threshed;† this yielded 39½ quarters of head corn, which having been sent early to market made 58*s.*, and 2 quarters 3 bushels of tail-corn. The sum realised was 106*l.* 10*s.*, or 10*l.* 12*s.* per acre; but at present prices it would make only 9*l.* per acre, and our early supplies are necessarily limited.

If we combine the results of these four consecutive years, the value of the respective crops per acre will be as follows:—

	Value per acre of Barley (on whole furrow).			Value per acre of Wheat.		
	£.	s.	d.	£.	s.	d.
1859	8	9	0	7	0	0
1860	8	4	0	9	10	0
1861 (nearly)	11	0	0	9	0	0
1862 over	10	0	0	10	12	0
	<hr/>			<hr/>		
Average	37	13	0	36	2	0
	<hr/>			<hr/>		
	9	8	0	9	0	6

But if we base our calculation for 1862, not on the small portion of the crop sold in harvest time, but on the general range of prices for the year, the value of that crop will be reduced to 9*l.*, which would pull down the wheat average to 8*l.* 12*s.*

The advantage derived from manuring and cultivating one-fifth or one-sixth of the ordinary wheat shifts at leisure on a light soil in a bleak climate, where backward wheats are in jeopardy,

* In this year, however, a small part received a folding, as well as a light coat of manure.

† The remainder, just threshed, has yielded 27 bushels, now only worth 7*l.* 7*s.* per acre.

every arable farmer will appreciate; and as a flock-master he will hardly know what value to put on a healthy run which assists him in keeping his ewes out of the turnips, or enables him to bring them by degrees to their new diet with a dry run, and bite of grass in the morning, and a fold, probably of rape, in the afternoon.*

My opinion that the barley crop takes less out of the land will be disputed by those who, from a knowledge of the analyses and ash of the various crops, think it a safe conclusion that because the barley crop, when ripe, contains as much of valuable constituents as wheat, it therefore takes up as much from the soil.

Our best chemists, however, consider that during the whole course of their growth, the cereals are parting with nitrogen to a considerable amount; this waste of the most costly constituent will therefore vary with the duration of the plant's growth, that is to say, will be greater in autumn-sown wheat than in spring-sown barley. Those who build most upon the supplies of ammonia to be derived from the air may be expected to look favourably on this theory of nitrogenous exhalations from plants. Otherwise (until we have better evidence that the nitrogen as united with oxygen in the air becomes largely available for plants) how can they account for the supply of ammonia and nitric acid on which they rely?

The opinion then that wheat and barley are equally exhausting crops perhaps arises from imperfect chemical knowledge, which sometimes misleads agriculturists of the present day, but not nearly as often as an *indiscriminate* application of the abstract dogmas of political economy.

But apart from any scientific speculations, the prospects of the wheat trade are precarious, those of barley steady; the new competition from foreign wines being counterbalanced by increased skill in brewing, and greater facilities for delivering beer within moderate distances: our growth of barley then may safely be increased on suitable soils.

I send this as an old member's contribution to the Journal, to indicate the sort of communications which are to be desired from such quarters.

* The fields I refer to cannot grow turnips, and, without such precautions, rape is dangerous for ewes, either before or after lambing, and also for hoggets. A run for a few hours in the morning over grass is highly conducive to health, if it be given merely for the sake of exercise.

REPORT OF A DISCUSSION ON SPLENIC APOPLEXY IN CATTLE AND SHEEP.

The last Meeting of Weekly Council, July 9th, 1862. The Earl of Powis in the Chair.

Professor SIMONDS said the remarks he was about to make with regard to the nature and probable causes of this disease—Splenic Apoplexy—the name of which he would explain presently—were to be considered as simply preparatory to the reading of some reports in relation to an appearance of the malady in Somersetshire. The attention of the Council was first called to the matter about six months since by Sir William Miles; and, as the veterinary officer of the Society, he received instructions to investigate the facts of the outbreak. On his return from the neighbourhood he prepared his report, having ascertained that the occupiers of the farms were no better acquainted with the causes of the malady than they were at its commencement. As there were good reasons to believe that certain pastures on two farms in particular gave origin to the disease, and as he also had found that the water in the district was of a peculiar character, he had recommended that a further investigation should be made by Dr. Voelcker, as chemist to the society, and by Professor Buckman, botanist, of the Royal Agricultural College of Cirencester, both of whom had prepared reports, which would be read to the meeting. The chief business of the day would, therefore, be the reading of these reports, which, with the discussion that would follow, might possibly throw some light on the causes of the outbreak.

This disease, which affects both cattle and sheep, had been designated splenic apoplexy because, on making a *post-mortem* examination, the spleen was found to be enormously engorged with blood; and there are some persons who regard this engorgement as the chief cause of the fatality of the affection. He thought, however, that, on looking a little deeper into the matter, pathologists would be inclined to regard the sudden filling of the spleen as the effect of a pre-existing morbid state of the blood, and not the cause of a change in this fluid, and if so, "splenic apoplexy" might be considered a misnomer. The disease was in reality one in which some of the constituents of the blood, from various causes, underwent peculiar changes; and in consequence of the disturbed state of the organism thereby produced, the blood was brought to a standstill in the spleen—hence the large increase of its bulk. This being the case, the chief use of retaining the term "splenic apoplexy" is to distinguish one blood disease from another.

In all parts of the country a large quantity of cattle and sheep, and even pigs, are lost from affections which clearly belong to the blood. In some of these cases several of the constituents of the

blood are increased in quantity, in others they are diminished, while in particular instances they have even undergone chemical changes. He would give some familiar examples.

There is a disease called "black-leg" in cattle, which is the pest of many a farm in Yorkshire and in some other counties, and particularly affects the rearer of young short-horn cattle. He had named this disease *Hæmato-sepsis*, because of the septic condition of the blood with which it was associated. Again, there is another malady, the "red water" in cattle, a disease to which cows are in some parts of the country more prone than oxen. This is a disease in which the blood undergoes peculiar changes, and in which the albumen and also the colouring matter of the red cells are evacuated through the medium of the kidneys, constituting the affection now known as *Hæmo-albuminuria*. There are other maladies in which the blood is brought to a sudden standstill, sometimes in one part of the body and sometimes in another. Cases of the kind occurred last year in Wales, and they were truly described as examples of stagnations of the blood—*Hæmostasia*. Thus there are several affections of a fatal character which primarily manifest themselves in certain changes of the blood, and he believed that splenic apoplexy was one of those affections.

The causes which give rise to blood affections are various. For example, the fluid is likely to become contaminated by the inhalation of noxious materials, and in very many instances life has been suddenly cut short by such influences. Many persons have supposed that in splenic apoplexy the changes originally wrought in the blood are due to the inhalation of ordinary malaria. This opinion received some degree of support from the circumstance that the malady often showed itself during the summer months in those districts where there was a large tract of low-lying land, which, for want of under-draining, yielded deleterious gases, from the operation of the sun's rays upon the decaying vegetable matter. But opposed to this view was the fact that, in the cases presently to be considered, the cattle were attacked on pastures which were in every respect like those on which others remained healthy, and from which they were separated merely by ordinary ditches. It was on two pastures in particular, and on two farms, comprising about 300 acres of land each, that the disease had shown itself, and in neither instance could sufficient reasons be found to believe that malaria had anything to do with the malady. Again, a more extended view, including attacks of the disease in other districts, would show that these often occurred in the winter, and among animals which were being prepared for the butcher, fed largely on mangold, oilcake, &c., and kept under circumstances favourable to the continuance of health.

Another common source of mischief is the direct conveyance into the digestive organs of materials, either in the shape of food or water, detrimental to the making of pure blood. Pathologists are often enabled to trace blood diseases directly to the food; but on examination of the cases in question, there was no evidence that

materials of a deleterious or poisonous nature had entered into the organism, and excited a fermentive action in the blood. Professor Buckman would explain at length the general nature of the herbage in the fields in question. His own remarks had reference merely to the fact that in the careful examination which he had originally made he had failed to detect any poisonous plants in the pastures.

Water enters largely into the composition of the blood. There are no less than 784 parts of water in every 1000 parts of blood; and, as water often holds in solution a variety of materials, and goes directly, so to express it, into the vessels from the intestinal canal, by the simple law of endosmosis, it follows that matters detrimental to the blood may be thus conveyed into the system, and induce certain changes in the composition and character of the blood which may prove fatal to life. In the district in question the water was strongly impregnated with sulphuretted hydrogen, and hence totally unfitted for man or animals.

But water, or rather a want of it, might likewise induce this disease. Two years ago he was consulted respecting an extensive fatality among some cattle in Norfolk, said to arise from splenic apoplexy. It was during the winter months, and the animals were being fed at the time on oil-cake, roots, hay, &c. On investigating the disease he was led to the conclusion that the water must be implicated in its production. He communicated this opinion to the owner, when he received the quaint reply, "You never made a greater mistake, for it is my custom not to allow my animals any water at all while in the sheds." He (Professor Simonds) hesitated not to express his belief that it was the want of water which induced a diseased condition of the blood in this instance. Of course such a state of things was altogether opposed to nature. To understand this the better, he would again remind them of the large quantity of water that naturally existed in blood, as this would show how the blood would necessarily become altered in its fluidity by an animal being deprived of water. The case would likewise help to prove that changes were wrought in the blood by causes the very opposite of each other.

An interesting question arises as to how far the spleen may be originally concerned in the production of a morbid state of the blood, and whether pathologists are justified in regarding the affection as depending essentially on changes in the function of the spleen. The use of the spleen is, even at the present time, but ill understood, and may be said to be almost an enigma in science. On the one hand, many eminent physiologists are of opinion that it has to do with the disintegration of the red corpuscles of the blood, which become broken up in its structure; while, on the other hand, there are physiologists of equal eminence who declare that the organ is a *preparer* of the red cells. The prevalence of these two opinions shows that the true physiology of the spleen is not well understood. If he might presume to give an opinion, he would say that he considered the spleen to be an organ which exerts a disintegrating power upon the red cells of the blood. He.

had been led to this conclusion by two or three different reasons. In the first place, it is found that the total quantity of solid matter in the blood of the splenic vein is often less by upwards of one-half than in the other vessels belonging to the so-called chylopoietic viscera. This anatomical fact, also, that the splenic vein unites with those of the chylopoietic viscera to form the vena portæ, is of value in rightly determining the question, it being thus made apparent that the liver exerts its special function of removing deleterious materials from the blood of the spleen equally with its so doing from that of the other viscera. If the splenic vein were carrying blood which was newly manufactured and fitted for general circulation, the vessel would not join the vena portæ, but proceed in a more direct course to the heart.

It is easy to understand that the spleen, if it became suddenly engorged, would have its office as a disintegrator of the blood-cells suspended, just as the function of any other organ is arrested when the blood within it is brought to a standstill. As is well known, all the functions of life are suddenly cut short by a large quantity of blood being determined to the brain, constituting what is ordinarily known as apoplexy. So likewise if the spleen receives an undue quantity of blood, and this is suddenly brought to a standstill, its function will be arrested. Although engorgement of the spleen may therefore be only an effect of a changed condition of the blood originally, yet when that engorgement takes place, and the functions of the spleen are interrupted, the blood will be further deteriorated, and the death of the animal facilitated.

A natural provision has, however, been made to enable the spleen to receive a large amount of blood without injury. Hence one other use of the organ is that of acting as a dilatable diverticulum for the blood, especially when obstructions exist in the vena portæ. If, therefore, the vena portæ be congested, the spleen will be suddenly increased in size; but when the congestion is removed, the blood will again flow from the spleen, and go rapidly through the vessels of the liver.

It is, therefore, no absolute proof of disease that the spleen is larger than commonly observed. If in this affection the spleen were simply enlarged, and no change were wrought in the blood, we might infer that the organ was chiefly at fault; but when on *post-mortem* examination being made, other parts distinct from the spleen are found to be affected, it is fair to conclude that the term "*splenic apoplexy*" is a misnomer, and that the enlargement of the organ is only a symptom of some other affection. In a *post-mortem* examination it would be observed that the small intestines, apart from the spleen altogether, are filled almost to repletion with blood, which has no power of coagulation, thus showing that it is changed in its vital properties. The intestines also have a blackened appearance, owing to an effusion of spoilt blood which has taken place within them.

On looking to the flesh of animals dying with the malady, extravasations of blood will likewise be frequently met with. Here,

again, is an instance of the blood leaving its vessels, and lying, as it were, in the interstices of the muscles. As with the abdominal effusions, so with those which take place in other organs of the body—the blood is always fluid.

It not unfrequently happens, if an animal bears up against the disease longer than ordinary—the duration of the malady being seldom more than eighteen hours—that such changes are wrought in the condition of the flesh as render it poisonous. Cases had come to his knowledge in which pigs, having eaten such flesh when thrown into a yard, had died within a few hours. Dogs had also been affected in a similar manner. These facts still further show that this disease is truly one that produces chemical changes in the blood.

The duration of the malady is necessarily short, the animals attacked seldom surviving more than twenty-four hours; indeed, the major part of them die in six or eight hours. Death sometimes takes place even within two hours after the attack. The percentage of deaths would often be found as high as ninety.

As to the symptoms, there are, as a rule, no premonitory ones. The animals usually feed and are apparently doing well up to the time of the attack. When the symptoms first show themselves they are also very often not of an alarming character. The animal stands with its back arched, it has a difficulty of progression, a staggering gait, and a twitching of the muscles. Paralysis succeeds. The countenance is dull and dispirited, and the head pendulous; a frothy saliva comes from the mouth; the breathing is laboured and difficult, and the pulse augmented, becoming tremulous and indistinct as the disease advances. Colicky pains come on, and when effusion into the intestinal canal takes place these pains are associated with diarrhoea and blood-coloured evacuations. The urine also is frequently discoloured with blood. The animal falls, and generally dies in convulsions, the immediate cause of death being cerebral disturbance. Some die frantic, others in a state of coma.

With regard to the treatment of the disease, no confidence can be placed in any one method in particular. All blood affections are exceedingly fatal, and generally run their course so quickly that scarcely anything can be done to arrest them. They may, however, often be prevented; indeed, prevention is the pathologist's chief concern, on which some light might be thrown in the discussion. His object was not so much to give a complete lecture on splenic apoplexy as to make a few remarks introductory to the Report, which he would now proceed to read:—

REPORT.

To the Veterinary Committee of the Royal Agricultural Society.

GENTLEMEN,—I have to report that, in accordance with your instructions, I have investigated the circumstances connected with the disease which has of late years prevailed among the cattle and

sheep in the vicinity of Ilchester, to which your attention was recently directed by Sir William Miles, Bart. On the day preceding the one—March 19th—that I received your directions to visit the district in question, a report reached me from Mr. Blake, veterinary surgeon, of Yeovil, describing the somewhat sudden reappearance of the malady on one of the farms, after several weeks' cessation, he having been called upon to make a *post-mortem* examination of three cows which had died after a very short illness. Mr. Blake also forwarded the greater part of the viscera of one of the animals, thereby affording me an opportunity of studying the pathology of the malady prior to my visit.

The lesions observed essentially consisted of an enormous engorgement of the spleen with grumous blood, and effusion of sanguineous fluid into the small intestines. The vessels of the mesentery, and especially those of the mesenteric glands, were likewise filled to repletion with black and partially coagulated blood. These appearances agreed with those which had been observed in the other cases by Mr. Blake, and clearly indicated that all the animals had fallen victims to the malady known as *splenic apoplexy*.

From causes at present not well understood, attacks of splenic apoplexy have of late years been greatly on the increase, and under whatever circumstances they may have occurred they almost invariably have had a fatal result. The rapidity with which they progress is remarkable, the affected animals often dying within an hour or two of being observed to be unwell. Sometimes the animals will bear up against the disease for six or eight hours, but very rarely for more than twelve. A long duration is favourable to recovery, but not a positive proof that such will take place.

The earliest symptoms are often not of an alarming character. The animal is mostly dull, and disinclined to move. It stands with its head hanging down, ears lopped, and back arched. In other cases twitchings of the voluntary muscles are observed, with loss of power of progression, especially with the hinder limbs. The surface of the body is chilly, the gait staggering, and the mucous membranes injected. Defluxion of tears, increased mucous discharge from the nostrils, laboured and painful breathing, and a quick, weak, and wavering pulse, also attend the progress of the malady. As the disease advances to a fatal termination, colicky pains come on, which are associated with an irritable state of the bowels and blood-coloured evacuations. The cerebral functions become more and more impaired. Rigors show themselves, and the animal drops and dies, either in a semi-comatose state, or, now and then, in strong convulsions.

From the evidence collected with reference to the cases in question, it appears that the disease was entirely unknown in the district until the summer of 1855. The outbreak, which cannot be accounted for, took place on a farm in the occupation of Mr. Edw. Look, of Ilchester. The farm consists of 300 acres, the greater part of which is pasture-ground, lying in the valley of the Yeo. I

learned from Mr. Look that in the month of August, 1855, he had thirty barren cows, varying in age from four to eight years, at pasture on a particular field—a piece of old feeding-ground—which had been going on to his perfect satisfaction up to the time of the appearance of the disease. These animals had been bought between Christmas and May-day, about which time they were turned out to graze. No indications of ill-health preceded the attack; but suddenly and within a few days thirteen of them died, some being found dead a few hours after being believed to be in perfect health. The remainder of the animals were at once disposed of, and within a day or two of the sale several more of them became affected and died. After their removal the pasture was fed with sheep during the latter part of the summer and the succeeding autumn, and a great many losses also occurred among these animals from the same disease.

The field in question, which, for distinction, I will name No. 1, is apparently a piece of good grazing ground. It lies on ridges, the valleys between which act as surface-drains. The greater portion of it is sufficiently dry, but the lowest parts would be improved by under draining. It contains twenty-seven acres, and is bounded on one side by the river Yeo, from which the animals obtain their drinking-water. It has been regularly fed since 1844. No difference was detected by me between the grasses it bears and those growing on the contiguous pastures, which hitherto have been perfectly free from the disease.

In the spring of 1856 some more cattle were turned into this field, and in the course of three weeks one of them died. The others were immediately removed, and with one exception they all did well. The animal thus alluded to died within two or three days of its removal.

The field was then shut up for mowing, and after the hay-making it was stocked with about a dozen *bulls*, all of which went on well. They were turned in almost immediately after the removal of the hay, and consequently before the growth of much after-grass.

In 1857 the same plan of mowing and stocking the after-grass with *bulls* was adopted, and without any loss.

In 1858, and also in 1859, the field was *partly* mown and partly fed with sheep. An occasional death took place among these animals.

In 1859 the disease appeared on another part of Mr. Look's farm—field No. 2, situated at a considerable distance from No. 1. It broke out among eleven feeding oxen, four of which were at once slaughtered. This also is seemingly a good piece of grazing land, and the animals pastured upon it have ready access to a brook of pure water.

In 1860 No. 1 was fed with sheep entirely, and the deaths being numerous, the animals were removed; after which the field was skimmed over with the scythe, and then fed with *bulls*, and again without any loss.

In this year two feeding cows died on No. 2. No loss occurred in No. 1 in 1861, although it was fed both with cattle and sheep. *It was, however, very heavily stocked.*

In 1861 many sheep were lost on No. 2. In February of the present year a horse and three sheep died on No. 2. The horse is said to have presented the same *post-mortem* appearances as the cattle and sheep, but scientific evidence is wanting on this point.

It is worthy of note that the sheep were only in the field for four or five hours, and on being put into another pasture, one died twelve hours afterwards, and the other two very early the next morning.

Mr. Look buys barren cows for fattening, and has had no cases of the disease on any other of the pastures, nor while the animals have been kept in the yards prior to being turned out to graze. The yards are good, well sheltered, and cleanly kept, and the animals have a supply of very good water.

MR. WAKE'S FARM.

This farm consists of 127 acres, all in one piece of pasture, being merely divided by some iron hurdles into four, or occasionally three parts, for the sake of convenience. It is contiguous to Mr. Look's, and only separated from field No. 2 by a narrow brook.

It is used as a dairy farm, and was in the occupation of Mr. Wake's father previously to Mr. Wake junior coming into possession at Lady-day, 1861. Mr. Wake's father kept, on an average, fifty-two head of cattle, including heifers and bulls. No disease existed among any of the animals before May, 1859, when the malady in question suddenly showed itself. Between May 11th and October 6th of this year seventeen died, one of the number being a bull. Some of the cows were in calf, others were milking, and a few of these grazing animals.

Immediately after these losses more cows were bought, so as to bring up the number to 50, and no deaths occurred either among these or the old stock of the farm throughout the winter.

Besides the seventeen animals which died in 1859 three others were attacked, but in a milder form, and these recovered.

In the spring of 1860 six dairy cows and one bull were lost, after which the disease disappeared until February of the present year. The bull had been on the farm about two months, and was between two and three years of age. As previously stated, Mr. Wake junior came into possession of the farm at Lady-day, 1861, and when he entered he brought with him from his previous occupation at Brougham, fourteen miles distant, thirty cows and heifers, of various ages. He also purchased twenty of the old stock belonging to his father. During the year eight of the cows brought from Brougham died, and two bulls which he had purchased soon after Lady-day, but one only of the old stock.

Two of the eight cows died in April, while feeding chiefly upon hay in the yard, going unto the pasture for a few hours only every day.

Another of the animals was milked in the evening, and yielded a full supply. She was shortly afterwards attacked, and died about 10 P.M.

The last animal which died on the farm was a cow kept principally in the shed on hay. Her death took place about the middle of February, 1861.

The sheds and yards are wet and dirty, and badly littered. The drinking-place is paved and walled with stones, and the supply of fresh water to it is very insufficient. It receives a considerable amount of the drainage of the yard. The land is liable to flood, lying rather lower than many fields by which it is bounded. It is, nevertheless, of fair average quality, and its natural herbage has been somewhat improved by manuring, which is done at such a rate as to complete the whole in about every seven or eight years.

The cattle, when grazing, have access to pure water from the brook previously described.

MR. DYKES' FARM.

The losses here have been only two. The land adjoins Mr. Wake's and is of the same description. The two animals died within a fortnight of each other in the spring of 1861. They were barren cows, bought for grazing.

MR. BRADLEY'S FARM.

This farm is situated in the parish of Sock, and is distant about a mile from the others. It is also a grazing farm, consisting of 350 acres, a small portion only of which is arable land.

Mr. Bradley has occupied the farm for twenty-nine years, and until the disease in question made its appearance has only lost animals now and then from ordinary causes. The parish of Sock contains only one other farm, which is in the occupation of Mr. Hussey, and it is a singular circumstance that no disease of the kind has ever existed here. This farm is precisely of the same nature and quality, and the system of grazing exactly the same. Many of the pastures are separated from Bradley's by ordinary water-courses only, and a good many of them are so situated as to unite Mr. Look's and Mr. Wake's farms with Mr. Bradley's.

It was in consequence of the disease having proved singularly destructive on Mr. Bradley's farm, and having continued, with few interruptions, down to the present time—March 24th—that Sir William Miles' attention was called to the subject, with a view to an inquiry being instituted by the Society.

Mr. Bradley, like Mr. Look, has found that the losses have occurred when the animals have gone unto two fields in particular, which are numbered respectively on the plan of the farm 30 and 37.

The malady was first observed in July, 1861, having broken out among nineteen grazing animals, which were, with a milking cow, at pasture in the same field. They had been turned into this field on May 4th, and had continued there until July 3rd, going on

quite satisfactorily. In consequence of the keep becoming short at this date, the *nineteen grazing animals* were taken out of the field—and put into another—a piece of good feeding ground, locally designated “*tart land*,” from its causing diarrhoea among the cattle when first placed upon it. Here they remained until the morning of the 7th, when they broke out, and were then turned into No. 30—a suspected field. They continued in No. 30 till the 10th, when they were returned to the original pasture, and where the cow had remained during the whole of this time. On the morning of the 11th four were found dead, and in consequence of this the remaining fifteen were taken into the yards and bled, and had administered to them some aperient medicine. Notwithstanding these precautionary measures, another of the animals died on the same day, and four more on the following day, the 12th. The remaining ten were again turned out, but into an unsuspected pasture, and of these, four died during the next day, the 13th.

The six animals which were left were afterwards kept off the suspected fields, and went on well. Two of them were sold for slaughtering a few weeks subsequently, being in good condition, and the other four during the autumn. The cow also, which, it has been shown, did not go unto the suspected land, has continued well down to the present time. She was neither bled nor physicked. The piece of “*tart land*,” on which the animals were placed on the 3rd of July, and where they remained till the 7th, when they broke out, is not thought to be injurious, in so far as the production of splenic apoplexy is concerned, because neither sheep nor cattle have ever died while upon it.

On the 26th of July the disease showed itself among another lot of fifteen grazing animals which had been on the farm for about four months. They were at pasture at the time of No. 37, not until then a suspected field. Three of the animals died on this day. The remaining twelve were then taken out, and no more deaths occurred. The field was then shut up and afterwards mowed.

On August the 27th a beast, which had been kept quite apart from the other animals, was put into the pasture adjoining No. 37, and was found dead in a secluded spot, after being missed for two or three days. This case is thought, however, to be a doubtful one of the disease.

During the latter part of the summer two colts at pasture on No. 30 died, and, as is believed, from the same disease.

On September 12th a beast died on No. 37. Had not been on No. 30.

On October 9th another beast died on No. 37, which also had not been on No. 30.

On December 22nd a third died *in the fold-yard*. It was one of eight, and was being fed at the time chiefly on hay, none of which, however, came from the field No. 37.

After this time the disease disappeared until the month of March in the present year.

On the 14th of this month a bullock feeding on hay in the yards

died suddenly, a second on the 15th, and a third on the 16th. These are the three animals previously spoken of as having been examined *post mortem* by Mr. Blake, and the viscera of one of which were forwarded for my inspection. They were part of a lot of ten bought on February 14th, at Bath fair, of the breeder. On their arrival at Sock, seven were selected from them and placed in the yards, and the remaining three were turned into the pastures, the suspected fields being avoided. These, with the four still in yards, were well at the time of my visit. The hay supplied to the animals came from different fields, and only about two loads of it from No. 30, none of which, it is thought, has yet been consumed.

I come now to the evidence obtained with reference to the deaths of the sheep on this farm.

In June, 1861, there were 205 shearling wethers grazing on different parts of the farm, and having free access to No. 30. Fifteen of these died between a Wednesday and Saturday, in consequence of which ninety were selected from out of the remainder and sent to the metropolitan market on the Saturday, four of which died on the journey. On the Monday following—the 1st of July—thirty more of the sheep were sold to a dealer, three of which died in a day or two afterwards. On this same day, also, Mr. Bradley lost two more out of the number remaining in hand. Those left were now put on vetches, which were rather a poor crop, and they were kept on them consequently only for a week. After this they returned to the pasture grounds, but were prevented going into No. 30. No further deaths took place. Since this time, other sheep on the farm have died at irregular intervals, down to February 1st, amounting in all to about thirty.

On the 5th of March last Mr. Bradley, with a view of arresting the progress of the malady, and to test the preventive properties of salt in doing this, applied 9 cwt. per acre, of this material to the field No. 30. He then drew out ten shearling-wethers from 140, and turned them into the field on March 7th. One of these animals died on the 15th. After this the nine were removed for five days, and then turned into the field again, without any additional death, however, up to the day of my visit. The experience of Mr. Bradley seems to show that if sheep are allowed to pasture on the suspicious grounds only for a few hours, they will take a sufficient amount of deleterious matter to produce their death a day or two afterwards. He considers the after-grass not to be so dangerous as that first grown, but he has no experience of bulls being less susceptible of the affection than other cattle.

Splenic apoplexy is essentially a blood disease, consequently it is not difficult for a pathologist to understand that it may arise from a variety of causes, any one of which is calculated to effect changes either in the quantity or condition of the several constituents of the fluid.

In investigating the causes, I was led to inquire into the water supply to the cattle when in the yards, especially as the three last animals had been lost while they had been exclusively confined to

these, and while also they were being fed entirely on hay. On inspecting the yards, I found them badly arranged, and by no means adapted for the preservation of the health of animals. This is particularly the case with the yards at the back of the house, where the animals alluded to had died. The feeding-bins, which are built of stone, are so placed that the water from the buildings runs towards them, and accumulates to such an extent that the cattle have to stand mid-leg deep in liquid manure, notwithstanding they may be fairly supplied with straw. The drinking-place is placed at even a lower level, and becomes a receptacle for so large an amount of the drainage of the yard that, but for a small flow of water from an adjacent pond conducted through it, the animals would be unable to obtain little else than their own evacuations diluted with the ordinary rain-fall. Nothing could be more objectionable than the water they had to drink. The other yards are somewhat better arranged, but still open to great improvements, both with regard to the supply of water and the comfort of the animals while at their feeding-bins. The drinking-place in one—the inner—yard receives a considerable portion of the drainage of the other, and it is worthy of note that the bullock which died in December was placed in this yard. A small stream flows at the bottom of both these yards, so that the animals in the other one can get good water, while those in the inner are compelled to drink it after it has become charged to some extent with drainage matters. In the absence of any other cause, I cannot but attribute the cases which occurred in December and also in March to the general want of comfort afforded to the animals, and their drinking of water charged with feculent matters—two things necessarily associated with the bad construction of the yards.

The cases, however, which have occurred during the summer months must have depended on causes of a totally different kind, and a further investigation may show that they were probably due to the general character of the herbage of the pastures on which the animals were placed. It has been already shown that the animals, when at pasture, can obtain a supply of good water, either from the river Yeo or from adjacent brooks, but, nevertheless, the entire water question requires a strict examination. Like many parts of Somersetshire, the district abounds in land locally called "tart-land," the herbage of which produces diarrhoea often to an alarming extent among the cattle. The real cause of "tartness" would appear not to be well understood, and scientific researches are therefore required for the proper solution of the problem. The character of the water in some places, apart from the herbage, is known to produce diarrhoea; and it not unfrequently happens that this condition of the water and "tart land" are combined. It does not, however, appear that "tart land" exercises any influence in the production of splenic apoplexy, or, at any rate, it seems not to have done so in the present instances. Were it otherwise, the disease would have been far more frequent in its occurrence than it has

been, and would also of necessity have persisted where the "tart land" exists.

It is a remarkable circumstance that in the parish of Sock, and also in the adjoining one of Tintinhull, the water, which is obtained by the sinking of wells on land which rises a few feet above the level of the valley of the Yeo, is so impregnated with sulphuretted hydrogen that it can only be used for ordinary cleansing purposes. On these farms the occupiers are obliged to collect rain-water from the roofs of the buildings for drinking and culinary uses. The fetor of the well-water is at times almost unbearable on being drawn by the pumps belonging to farm-residences.

On the farm in the occupation of Mr. Bradley the surplus of the house water from the pump mixes with the fetid sewage, and also partly with the drainage of the cattle-yards, and then finds its way to the bottom of the meadow No. 30, in which many animals have died; but it does not go near to the other meadows where also the disease has manifested itself. Besides this, No. 30 meadow, which has a considerable fall from its upper to its lower part, is so situated as to induce the belief that water, charged with organic matters which yield sulphuretted hydrogen, may percolate the sides of the slope and impart some deleterious principles to the herbage. This is a point which requires further investigation, and should be undertaken by those who possess a chemical and also a geological knowledge. To show the singular geological condition of the locality, I may state that Mr. Bradley, some years since, with a view of getting good water for his house, sunk a well on the level of the valley, and within a hundred and twenty yards of the original one, which yielded water so impregnated with saline matters that it also could not be used.

On inquiring into the water supply on Mr. Hussey's farm, which up to the present time has been perfectly free from the disease, I ascertained that about six years since a well, which yielded fetid water, was covered in, and the water from a brook diverted so as to supply a tank, from which it is pumped for the use of the cattle.

This was done in consequence of the animals refusing to drink the fetid water, or when doing so becoming attacked with diarrhoea. The tank is situated about forty feet from the well, and at times its water has a slight unpleasant smell, arising, as is supposed, from leakage, either from the well or from the surrounding soil.

My next visit was to Mr. Taylor's farm at Tintinhull, and was made chiefly because I was informed that the cattle here *constantly drank fetid water*, and that their health was in no way affected. On inspecting the premises, however, I found that this was not the case, and that the term "bad water" was used synonymously with fetid water. The water given to the cattle is drawn from a pump in the shed, and is conducted by pipes into small drinking-troughs made of iron, and placed in front of the stalls. It is apparently largely impregnated with the salts of lime, has a somewhat chalybeate taste, and is not very clear; but, nevertheless, it is not more

objectionable for animals than most hard waters. The well yielding the fetid water is situated within fifty yards of this one, and was originally made with a hope of obtaining water less turbid and better suited for domestic purposes. It is uncovered, and, on gauging it, I found it was only twenty-seven feet deep, fifteen of which were occupied with water, so that it would appear that the organic matters which produce the sulphuretted hydrogen are superficially placed in the soil. It is a singular fact connected with this well, that the water was comparatively sweet until a leaden pipe connected with a pump near the house was placed in it, with a view to obviate the trouble of going each time to the well for water. The first water drawn from the pump in the morning is not only so exceedingly fetid as scarcely to be borne, but is dark in colour; and although this colour soon passes off, the fetor is always very much greater than that of the water in the well.

The facts thus reported upon show the necessity of a chemical examination of the waters of the district, and also the necessity of a botanical examination of the herbage, and as such my investigations are to be considered as preliminary rather than otherwise. Already several samples of water have been sent to Professor Voelcker, and will doubtless be, in due time, reported upon. These waters were taken from Mr. Bradley's farm, and consisted—1st, of water from the pump; 2ndly, from the drinking-place in the cattle-yard behind the house; and 3rdly, from the ditch which flows directly into the drinking-place from the pond previously described. In addition to the chemical and botanical investigations, I would suggest that, to lessen the effects of some of the causes in a practical manner, the suspected fields be thoroughly underdrained, and be dressed with lime. That, instead of being fed in the spring, they be shut up for mowing, and afterwards stocked heavily with strong-constituted animals; and, as further precaution for preserving the health of the cattle in the yards during the winter, that the hay taken from these fields be well salted when being put into the stack.

As further preventives in Mr. Bradley's case, I would suggest that the cattle-yards be entirely remodelled, so as to prevent the animals standing up to their knees in wet and filth while at the feeding-bins: and that means be taken to give them a supply of pure water to drink, by conducting the streams now passing through them into stone tanks placed above the level of the drainage of the yards.

As these things belong rather to the future than the present, I have recommended Mr. Bradley to supply his animals with an improved diet, by adding some cake, corn, or bran daily, with good hay-chaff, to their ordinary allowance of hay, so as to lay the foundation for a better quality of blood. With a further view also of keeping their systems in a state better calculated to resist the disease, I have advised that an occasional dose of aperient medicine, consisting simply of Epsom salts, with a little ginger, be given, and after its effects have passed off, that each animal take two drachms

of nitrate of potash, mixed with a bran mash, for two or three days in succession. It is to be hoped that these means may prove beneficial; but prevention of the disease during the winter months must, in Mr. Bradley's case, be mainly based on sanitary improvements. Subsequently to my inspection I received from Mr. Bradley the carcass of a sheep which had died very suddenly on the field No. 30, making the second which had been lost after the application of the salt. The lesions which were discovered on the examination distinctly proved that the animal had sunk from the same disease. The blood was everywhere black in colour and only partially coagulated, and the spleen was enlarged to about three times its natural size. In concluding this report I would express a hope that the causes of this fatal malady may yet be made evident by the co-operation of the chemist, the botanist, and the animal pathologist, so as to lead to the adoption of effectual preventive measures.

(Signed) JAS. B. SIMONDS.

Report of the Examination of the Pastures in the neighbourhood of Ilchester, Somerset. By PROFESSOR BUCKMAN.

The little town of Ilchester is situate on an alluvial plain, through the centre of which the river Yeo takes its more or less winding course.

This river flat, which varies in width to as much as five miles, has a subsoil of alluvial mud and sand, intermixed with more or less of the southern or flint drift.

The land, which is in grass, is subject to flooding from the Yeo and its tributaries, and is distinguished by the terms, "useful meadow," "marsh," or "moorland," according as it offers facilities for preventing the stagnation of the water, and so will pay for manuring and other cultivative processes. These flat meadows may further be said to occupy a valley of denudation in the Lower Lias shales, the spoils of which, mixed with sandy silt and the flint drifts before mentioned, form the subsoil of the valley, which latter is bounded by low eminences, whose washed sides present the stiff intractile soil so characteristic of "*unmitigated blue lias*."

Now these two positions, namely, the river flats on the one hand and the liassic elevations on the other, are here remarkable as being concerned in the production of two kinds of disease in the animals that feed upon the pastures. Thus, the lowlands are dotted with meadows which the farmers point out as having been fatal to the cattle and sheep which have fed upon them, producing a malady which has been described as "splenic apoplexy," whilst the higher meadows have the name of "scouring" or "tart lands."

It should here be mentioned that the well waters which I tasted were all more or less of a medicinal class, the water from some wells at Bierly Farm, Tintinhull, and Sock, for example, being strongly impregnated with sulphuretted hydrogen, whilst that of others might be described as *mineral* or *saline* waters. In fact, the waters reminded me very forcibly of those in the vale of Gloucester.

At Cheltenham and Gloucester, the different waters of the various "spas" would appear not only to be like those of Somerset in chemical composition, but to be also derived from the same *formation* and under like geological conditions. The facts so far described were noted on the 20th of June, on which day, at the request of the Secretary of your Society, I proceeded in company with Professor Simonds to the neighbourhood of Ilchester. The following day was devoted to an examination chiefly of the herbage of the district; the results of which I now lay before the Society.

On visiting Bierly Farm, I first examined the water of two wells:

Well 1.—Twenty-seven feet deep, had twelve feet of highly fetid sulphur water.

Well 2.—Pronounced to be good water by the farmer, Mr. Taylor. It is about fifty yards from No. 1, and said to be eighteen feet deep. The water, judging from the taste, is impregnated with iron.

The ditch-water of this farm is considered good.

A large upland meadow on this farm was pointed out as being "very TART;" in this, the following were the prevailing plants:

Ranunculus bulbosus (bulbous buttercup), *Cynosurus cristatus* (crested dogtail), *Avena flavescens* (yellow oat-like grass), *Dactylis glomerata* (cocksfoot).

Here the great mass of the bulbous crowfoot and the dogtail is highly significant of a poor hungry pasture.

From this farm we proceeded to Sock, where I would first note that the open farm-yards are bounded by buildings with large roofs and with no spouts to carry off the water. Under such circumstances, the cattle must triturate their manure with the rain that falls, and with the juices oozing therefrom their drinking-water becomes contaminated.

PLANTS IN FIELD 18, SOCK FARM.

Botanical Name.	Trivial Name.	Proportionals.
<i>Ranunculus bulbosus</i>	Bulbous buttercup	10
„ <i>acris</i>	Upright „	5
<i>Carduus arvensis</i>	Creeping thistle	8
<i>Potentilla anserina</i>	Silver weed	12
<i>Trifolia</i>	Clovers	1
<i>Cynosurus cristatus</i>	Crested dogtail	20
<i>Aira cæspitosa</i>	Tussac grass	5
<i>Poa trivialis</i>	Rough-stalked meadow grass	5
<i>Hordeum pratense</i>	Meadow barley	1
<i>Festuca pratense</i>	„ fescue	scarcely represented.
<i>Lolium perenne</i>	Rye grass	
<i>Carices</i>	Sedges, var.	6
<i>Junci</i>	Rushes, var.	3

Herbs of a good kind barely represented.

On this farm, field No. 18, described as "tart land," is much out of condition from want of drainage. I would here note that most of these tart lands suffer for want of under drainage; they are poor, hungry clays, on which manure is found not to exert the influence that might be expected, and, indeed, that it undoubtedly would do if preceded by draining. The following is a list of some of the observed plants to which I have attached numerals expressive of their quantities. This list and the successive ones, though not pretending to be complete, is near enough for all practical purposes.

In this field we have bad herbage in the ascendant. All the plants, including the mass of the grasses, show a mixed condition of poor land both wet and dry. Anything like good species of grasses are only just indicated, there being an occasional sprinkling of such, and little more than this of the clovers.

The next three meadows, namely :

1st, No. 23 and 24.—"Higher Carey's Mead," now in hay; is better than No. 18.

2nd, No. 28.—"Middle Carey's Mead," a low meadow flooded in winter; mown for twenty-five years; this year in pasture.

3rd, No. 29.—"Lower Carey's Mead," much drier than No. 28; now in pasture.

These three meadows are not tart, or, if so, it is only to a slight degree in the upper one. They differ much in quality; the last being much the best, arising partly from its being in a sounder state.

PLANTS IN FIELDS 28 AND 29.

Botanical Name.	Trivial Name.	Proportionals.	
		No. 28.	No. 29.
<i>Ranunculus acris</i>	Upright buttercup	20	10
<i>Trifolium pratense</i>	Red clover .. ..	..	3
,, <i>repens</i>	Dutch clover .. ..	..	2
<i>Aira cæspitosa</i>	Tussack grass	10	3
<i>Cynosurus cristatus</i>	Crested dogstail	6	5
<i>Holcus lanatus</i>	Woolly soft grass	4	2
<i>Hordeum pratense</i>	Meadow wild barley	3	2
<i>Briza media</i>	Quaking grass	2	1
<i>Poa trivialis</i>	Rough-stalked meadow grass ..	6	5
,, <i>pratensis</i>	Smooth ,, ,, ..	3	6
<i>Festuca pratensis</i>	Meadow fescue, varieties ..	4	6
,, <i>lohiacea</i>			
<i>Bromus commutatus</i>	Tumid field brome	3	3
<i>Lolium perenne</i>	Rye grass	3	6
<i>Anthoxanthum odoratum</i> ..	Sweet vernal grass	2	3
<i>Carices</i>	Sedges in the grips	5	..
<i>Junci</i>	Rushes ,, ..	4	..
Good herbage .. ..	.. ..	15	21

A comparison of the grasses in these meadows will be sufficient to show the difference, bad plants, poor grasses, and others, prevailing in twenty-eight, whilst in twenty-nine these are much less, and good grasses more plentiful.

I would now direct attention to Mr. Hussey's field, which is said to be very tart. This is quite on the upland or lias elevation, and was described to me as being exceedingly rich; so much so, indeed, that it had been mown for twenty years without any dressing. It was pronounced to have "looked beautiful in spring." At the time of my visit it had been depastured, and I saw the second growth of fresh grass, which certainly was not deficient in quantity; however, as regards its quality, I can only pronounce that the species of grass show a soil with sufficient moisture, but cold and poor.

The prevailing grasses are as follows, placed somewhat in their order of frequency:

Arrhenatherum avenaceum (oat-like grass).

Poa trivialis (rough-stalked meadow).

Holcus lanatus (woolly, soft, grass).

Hordeum pratense (meadow wild barley).

Cynosurus cristatus (crested dogstail).

Bromus mollis (soft brome or lop).

Dactylis glomerata (cocksfoot).

Festuca duriuscula (hard fescue).

Lolium perenne nearly absent.

Clovers only in very small quantity, and I think the prevailing species is *Trifolium fragiferum* (strawberry-headed trefoil) a denizen of lumpy clays, often mistaken for the Dutch clover. Upon this point, however, I am not certain, as I could not find a specimen in flower.

From these observations on the tart lands which came under my notice, I am induced to conclude that they are poor, cold, "hungry clays." They want draining *as much to let the air into the soil as to get the water through and out of it*; after which, liberal manuring will be found to act, though now I am told these lands are not manured, as they are said "not to be grateful for it."

Since the above notes were penned, I have seen a paper by Professor Voelcker on the 'Tart Lands of Central Somerset,' from which I take the liberty of quoting a concluding note of Lord Portman:

"I am of opinion," writes his lordship, "from what I have tried and observed on the 'tart' lands of Pylle, where, I regret, Professor Voelcker has not made an inspection, that the plough is the true remedy, and all 'tart lands' should be converted into arable lands. The clover-hay, the pasture on the clover-lea, and the roots fed by sheep on such land have no scouring properties; and, after a fair trial of some bad scouring lands, I have advised my tenant to break up and cultivate several scouring fields, which will, as I be-

lieve, be profitable instead of noxious land."—Lord Portman in the '*Bath and West of England Agricultural Journal*.'

I would remark that this is an opinion clearly borne out by the botany of the "tart lands" near Ilchester. Arable cultivation, however, would be very imperfect if not preceded by draining, and these would then be strong yielding lands with the usual manuring in the different rotations. So thoroughly convinced am I that, if found desirable to retain them as pasture, they may be made to yield good herbage of a wholesome kind as the result of cultivation. The more meadows of this kind are cultivated, the less frequent will become the poorer grasses, which yield pasturage and hay with what the farmers call "no proof" in it, while the better kinds at the same time will gain a complete ascendancy.

The meadows next to be described are those in which have occurred cases of "splenic apoplexy."

I first notice No. 30 on Mr. Bradley's farm at Sock. This meadow is on a gentle slope, the lower half of which is a poor swamp, the upper portion sounder and with better herbage; the prevailing plants in the lower part are separated from those of the upper portion. It will be seen that the mass of the herbage in the flat is composed of the marsh thistle, sedges, and rushes, whilst the upper portion consists of grasses and clovers.

PLANTS IN No. 30, SOCK.

Botanical Name.	Trivial Name.	Proportionals.	
		Flat.	Upland.
<i>Carduus arvensis</i>	Creeping thistle .. ..	..	..
,, <i>palustris</i>	Marsh plume thistle	10	..
<i>Carices</i>	Sedges	10	..
<i>Junci</i>	Rushes	5	..
<i>Ranunculus acris</i>	Upright buttercup	5	..
,, <i>bulbosus</i>	Bulbous .. ..	..	2
<i>Hordeum pratense</i>	Meadow wild barley	3	1
<i>Cynosurus cristatus</i>	Crested dogtail	1	2
<i>Aira cespitosa</i>	Tussac grass	5	..
<i>Arrhenatherum avenaceum</i>	Oat-like grass .. ..	..	2
<i>Lolium perenne</i>	Perennial rye-grass .. ..	..	3
<i>Festuca duriuscula</i>	Hard fescue .. ..	..	3
,, <i>pratensis</i>	Meadow fescue .. ..	..	2
<i>Poa trivialis</i>	Rough-stalked meadow grass	5	3
,, <i>pratensis</i>	Smooth .. ..	..	3
<i>Dactylis glomerata</i>	Cocksfoot .. ..	..	6
<i>Holcus lanatus</i>	Woolly soft grass	3	3
<i>Avena flavescens</i>	Yellow oat-like grass	1	1
<i>Trifolium pratense</i>	Red clover	1	3
,, <i>medium</i>	Dutch clover	1	2
<i>Oenanthe pimpinelloides</i>	Water dropwort*	1	..
Good herbage .. ..	.. ..	5	24

* The repetition of this and other plants of old salt marshes in this district is very interesting.

Taking this field as a whole, my conclusions are, that under-drainage and liberal treatment would tend to the removal of disease, as by such means the poorer sorts of meadow plants, including the poor grasses, would be discouraged and die out, whilst the better kinds would increase.

That land of this kind is productive as arable was made manifest by the appearance of a fine crop of wheat in a field adjoining No. 30; still the peculiar nature of the stiff soil is even here made known by the presence of the corn buttercup (*Ranunculus arvensis*).

I next direct attention to No. 39, which was described as a meadow which had produced "splenic apoplexy," but in a minor degree compared with No. 30. It was remarked as generally free from thistles and large weeds, if we except the prevailing plant of these marsh lands, namely, *Ranunculus acris*. Among the grasses will be noticed *Anthoxanthum odoratum* (the sweet vernal grass) to the spicy character of which I am inclined to attribute its improved quality when compared with No. 30.

PLANTS IN No. 37.

Botanical Name.	Trivial Name.	Proportionals.
<i>Ranunculus acris</i>	Upright buttercup	15
<i>Aira caespitosa</i>	Tussac grass	10
<i>Cynosurus cristatus</i>	Crested dogtail grass	10
<i>Bromus commutatus</i>	Tumid field brome grass	3
<i>Poa trivialis</i>	Rough-stalked meadow grass	3
<i>Holcus lanatus</i>	Woolly soft grass	5
<i>Anthoxanthum odoratum</i> ..	Sweet vernal grass	2
<i>Alopecurus pratensis</i>	Meadow foxtail	1
<i>Trifolium pratense</i>	Red clover	3
Good herbage .. ..	.. ..	12

The above makes soft hay of the kind, which is said to be wanting in "proof." The absence of rye-grass and fescues is very observable.

This meadow, though under water in winter, was not swampy, like parts of No. 30, at the time of my visit.

The next field to be described is situate near the Victoria Inn, Ilchester. It is constantly cut for hay, the practice being on this farm "to always mow the same land and manure it, and to let the feeding land take care of itself," the principle at the bottom of this practice apparently being that the better pastures yield more and better hay, as being sounder and drier, and therefore can be manured to advantage; while the low meadows do not yield good hay, and if quite exhausted by frequent haymaking, manures will not act by reason of the stagnant condition of the water.

PLANTS IN MEADOW NEAR THE VICTORIA.

Botanical Name.	Trivial Name.	Proportions.
<i>Ranunculus acris</i>	Upright crowfoot	10
<i>Aira caespitosa</i> *	Tussac grass	5
<i>Cynosurus cristatus</i>	Crested dogtail	5
<i>Hordeum pratense</i>	Meadow wild barley	3
<i>Holcus lanatus</i>	Woolly soft grass	2
<i>Alopecurus pratensis</i>	Meadow foxtail	3
<i>Lolium perenne</i>	Perennial rye grass	3
<i>Anthoxanthum odoratum</i> ..	Sweet vernal grass	3
<i>Festuca pratensis</i>	Meadow fescue	2
<i>Avena flavescens</i>	Yellow oat grass	1
<i>Trifolium</i>	Trefoils	4
Good herbage .. ..	.. ..	18

This field I should have expected would be free from diseases ; and I have no hesitation in affirming that, in no case of what was described as "diseased ground," did I find anything like the quantity of the last six plants in the above list.

Beyond the above field is a large tract of ground, which is flat and marshy ; here occurs a field divided into three parts, in the occupation of Mr. Wake.

These three parts were described as varying in their power to produce disease.

The whole hundred acres were tolerably free from good grasses : these, however, were more plentiful in the higher part, which had been more often manured "because it pays better," and here *there has not been so much disease*.

It should be noted that in one part of the field described as *sound*, and certainly dry on the occasion of my visit, I yet observed a considerable quantity of *Alopecurus geniculatus* (*floating* (!) *foxtail*), a plant which sufficiently indicates that wet prevails over the greater part of the year. Here one does not wonder that there should be disease.

It now remains to notice Mr. Look's meadows, which I shall first do in the order in which I saw them, commenting more particularly upon them afterwards.

First we went through some sound pastures, in which good grasses abounded. In them there had been no disease.

"Middle and home ground."—Little of good grasses ; grips full of *Aira caespitosa* : disease.

"Pill-Bridge ground."—Laid down six years ; rye-grass and Dutch clover prevail : no disease.

"Beaton's Leas."—Improved by cutting up the tussac grass. Considered it at present the best meadow in summer.

* In this instance the tussac grass was diffused with the rest of the herbage, not in bull pates, as it occurs in wet or stagnant spots.

"Little Foot's Mead."—Good grasses prevail; buttercups few; dry: no disease.

"Raymond's Ground."—A dry pasture; cutting a fair weight of grass; but this consists of inferior species.

"Webb's Ground."—A dry soil, of the same kind as the last, only parted by a hedge. This field has been manured six or seven times in ten years. Some ten years since it did not belong to the farm; it had been badly treated, but is now improving. There were cases of disease here in 1859.

The analysis of the herbage of these two fields is given by way of contrast with that on Mr. Bradley's farm. From this it will be seen that plants other than grasses were either absent or so scarce as not to be worth noticing.

PLANTS IN (1) RAYMOND'S GROUND, (2) WEBB'S GROUND.

Botanical Name.	Trivial Name.	Proportionals.	
		1.	2.
<i>Bromus mollis</i>	Soft brome, or lop grass	20	..
<i>Hordeum pratense</i>	Meadow barley	10	5
<i>Cynosurus cristatus</i>	Crested dogstail	5	2
<i>Lolium perenne</i>	Rye grass	3	3
<i>Dactylis glomerata</i>	Cocksfoot	1	..
<i>Holcus lanatus</i>	Woolly soft grass	3	10
<i>Avena flavescens</i>	Oat-like grass .. ..	..	5
<i>Anthoxanthum odoratum</i>	Sweet vernal grass .. ..	..	1
<i>Trifolium pratense</i>	Red clover	3	..
„ <i>repens</i>	Dutch clover .. ..	..	..
Good herbage .. ..	.. ..	12	13

These two lists offer some curious distinctions, the quantity of lop in (1), and its absence in (2). In (2) the rye-grass was remarked as small in size, and it was found only to have been sown in 1861. Sowing good grasses with clovers may be mentioned as a plan for ameliorating these pastures, if united with manuring and less hay-making.

A general review of the pastures of this farm offers convincing proof that although drainage has not been overlooked nor cultivation neglected, yet there is great poverty, not so much in the quantity as in the quality of the herbage; and this poverty has not so much reference to poorly grown good species as in the general absence of these, and the abundant presence of the more innutritious kinds. These pastures as a whole appear to me to have undergone in past years exhaustive treatment, and though now beginning to improve, they will yet require a long time to get them to what they may become.

As a summary of the whole subject of my inquiry, I would remark in conclusion :

1st.—That the tart lands of Somerset are situate for the most part on poor unmitigated lias clays, which from the want of culti-

vation yield an abundance of poor species of fodder plants and a paucity of good kinds.

2nd.—That drainage by letting water and air through the soil would be of benefit in altering the mechanical texture of the land; whilst mowing would have the action of encouraging the growth of good grasses and discouraging the bad.

3rd.—That though the saline and medicinal waters which abound in these meadows may aid in the observed effects upon cattle; yet that the basis of the mischief is probably poor herbage.

4th.—As regards the pastures producing splenic apoplexy—these are for the most part in low positions, subject to floodings from the river Yeo and its tributaries. They are more or less marshy and stagnant. They contain a mass of weeds (*e.g.* the *Ranunculus acris*, *carices*, *rushes*, &c.), of no use, and of grasses so rough or so poor as to be little better than weeds.

5th.—These meadows, where subject to floods, if they cannot be controlled, may yet be greatly relieved by such drainage as the circumstances will allow.

6th.—It must be admitted that on Mr. Look's farm there is a better appearance of things; the pastures are not so wet, and he is trying to introduce better grasses and clovers into them; but that even here the mass of the present herbage consists of poor innutritious grasses, I have no doubt.

7th, and lastly.—I would beg to record the opinion that when as much science is brought to bear upon the cultivation of pasture as of arable land, these pastures will then be greatly improved, and that such improvement will be marked by an increase of plants now as it were struggling for existence, and a corresponding extermination of such as mark either wet, exhaustion, or natural poverty, or a combination of these conditions. To this end, I would venture to suggest that the arterial drainage of the *whole district* should be looked to, and that the system of always taking hay from one meadow and depasturing another, should be inquired into, and, consequent upon this, an attempt should be made to weed, and to introduce, where absent, some better species of herbage to replace the poorer kinds.

Professor VOELCKER followed, and remarked that he had a very short report to make. He had analysed four different kinds of water, and among them there was only one which was not largely impregnated with enough of both mineral and organic matter to produce disease. One sample in particular contained no less than 235 grains of solid matter in the imperial gallon, composed of various medicinal salts, which must necessarily affect the whole constitution of animals. He did not feel in the least surprised that cattle supplied with such water had become the subjects of serious disease.

The CHAIRMAN—What water was it?

Professor VOELCKER said the water was taken from the pump at Mr. Bradley's farm. It was clear-looking water, but was nevertheless very foul indeed, as the following analysis would show:

No. 1.

Composition of Pump-Water from Mr. Bradley's Farm, Seck.

An imperial gallon contained :						Grains.
Solid matter (dried at 230° Fahr.)	..	..	..	..	..	235·20
Consisting of—						
Organic matter	..	..	..	..	..	17·93
Mineral matters	..	..	..	..	..	217·27 grains.
Consisting of—						
Sulphate of lime	..	..	..	..	..	88·20
Sulphate of magnesia	..	..	..	..	..	41·81
Oxide of iron and alumina	..	..	..	..	..	1·60
Silicate of potash	..	..	..	..	..	2·52
Nitrate of potash	..	..	..	..	..	1·94
Sulphate of soda	..	..	..	..	..	24·65
Carbonate of soda	..	..	..	..	..	28·52
Chloride of sodium	..	..	..	..	..	28·03
Total per gallon						235·20

Among other things, it contained nitric acid, as much as one grain to the imperial gallon, and nearly eighteen grains of organic matter; showing that, somehow or other, refuse materials accumulated near to the surface of the soil, underwent regular nitrification, and found their way, in a more or less oxidised state, into the pump-water. Then, again, there was a large proportion of sulphate of soda, sulphate of lime, sulphate of magnesia, and other saline matters. These salts in their combination had a medicinal effect very much greater than that which they produced separately. It was a well-known fact that in certain districts of Somersetshire, where tart or scouring lands prevailed, medicinal effects frequently occurred. On referring to the composition of some water in a district near Bridgewater, he found that it contained 202 grains to the imperial gallon, while the water on Mr. Bradley's farm contained 235 grains. It was, unquestionably, a medicinal water, a single tumblerful of it taken in the morning being sufficient to produce a decided effect. There could be no question, then, that in a lias district there were materials in the waters having a tendency to produce disease; whether it were splenic apoplexy, scouring, or some other affection, he could not say, but that such water could not be drunk with impunity was certain.

Another sample of water was evidently largely impregnated with the drainings of the farmyard, and the evacuations of the animals. It must be undesirable that animals should drink such water, as all impurities of this kind were highly injurious. Its analysis (No. 2) is shown overleaf.

The ditch water—a third sample—and apparently foul, proved on analysis to be the purest of any. It contained only twenty-six grains of solid matter in the imperial gallon, and in this there were only four and a-half grains of organic constituents. This will appear from the subjoined particulars (No. 3).

No. 2.

Composition of Yard-Water from Mr. Bradley's Farm.

An imperial gallon contained :										Grains.
Solid matter	..	..	..	..	..	..	..	..	..	43·04
Consisting of—										
Organic matter	..	..	..	..	..	..	..	..	..	5·20
Mineral matters	..	..	..	..	..	..	..	..	..	37·84 grains
Consisting of—										
Sulphate of lime	..	..	..	..	..	..	..	..	..	5·61
Carbonate of lime	..	..	..	..	..	..	..	..	..	13·87
Carbonate of magnesia	..	..	..	..	..	..	..	..	..	2·94
Chloride of sodium	..	..	..	..	..	..	..	..	..	2·49
Other alkaline salts	..	..	..	..	..	..	..	..	..	0·81
Oxide of iron and alumina	..	..	..	..	..	..	..	..	..	2·06
Silica and insoluble siliceous matter (chiefly suspended matter)	..	..	..	..	..	..	..	..	..	10·06
Total per gallon										43·04

No. 3.

Composition of Ditch-Water from Mr. Bradley's Farm.

An imperial gallon contained :										Grains.
Solid matter	..	..	..	..	..	..	..	..	..	26·64
Consisting of—										
Organic matter	..	..	..	..	..	..	..	..	..	4·80
Mineral matters	..	..	..	..	..	..	..	..	..	21·84 grains.
Consisting of—										
Sulphate of lime	..	..	..	..	..	..	..	..	..	3·45
Carbonate of lime	..	..	..	..	..	..	..	..	..	9·31
Carbonate of magnesia	..	..	..	..	..	..	..	..	..	3·08
Chloride of sodium	..	..	..	..	..	..	..	..	..	1·68
Other alkaline salts	..	..	..	..	..	..	..	..	..	0·60
Oxides of iron and alumina	..	..	..	..	..	..	..	..	..	1·68
Silica and insoluble siliceous matter	..	..	..	..	..	..	..	..	..	2·14
Total per gallon										26·64

The well water at Tintinhull (No. 4) was a hard water, which he would not recommend any one to use permanently, although the animals apparently were uninjured by it. It contained some oxide of iron, which might tend to counteract its injurious influences. Another sample of water, taken from a second well at Tintinhull, near to the one just alluded to, had, when he received it, no fetid smell, but it soon developed sulphuretted hydrogen in considerable quantities, which evidently arose, not so much from organic matter, as from the reduction of sulphate of lime and other sulphates. The leaden pipe, to which Professor Simonds had referred, would exercise a similar reducing action, adding to the foster by producing an increased amount of sulphuretted hydrogen. The black colour arose from the production of sulphuret of lead. The analysis of No. 4 was as follows :

No. 4.

Composition of a sample of Hard Water from Mr. Taylor's Farm at Tintinhull.

An imperial gallon contains—										Grains.
Solid matter	..	..	..	..	..	..	..	..	..	70·88
Consisting of—										
Organic matter	..	..	..	..	..	..	..	..	..	4·64
Mineral matters	..	..	..	..	..	66·24	grains.			
Consisting of—										
Sulphate of lime	..	..	..	..	..	..	..	..	..	24·17
Carbonate of lime	..	..	..	..	..	..	..	..	..	12·68
Carbonate of magnesia	..	..	..	..	..	..	..	..	..	8·30
Chloride of sodium	..	..	..	..	..	..	..	..	..	12·03
Other alkaline salts	..	..	..	..	..	..	..	..	..	5·76
Oxides of iron and alumina	..	..	..	..	..	..	..	..	..	1·70
Silica	..	..	..	..	..	..	..	..	..	1·60
Total per gallon										70·88

If he understood the matter aright, this disease prevailed in the lias district in Somersetshire.

On the tart lands prevailing on the lias clays, the herbage frequently remained unripe, and in this condition it produced several disorders. It might be worth while to examine chemically the herbage of the meadows where splenic apoplexy occurred, in order to ascertain whether an unripe condition of the grasses had anything to do with the disease. As regarded the condition of the herbage, he had found a remarkable difference between sound pasture and the pasture of scouring lands. Peats always produced sound herbage. There were clays which were well-drained, but which nevertheless required to be exposed to the air and cultivated, and for which he believed the only remedy was the plough. They were naturally rich; they were not poor in the sense of a deficiency of food; there was plenty of mineral and organic food in the soil, but it was all locked up, and it was for this reason and the cold and frequently wet condition of the soil that the herbage did not get ripe. He had found great differences in the chemical composition of the perfectly ripe produce of peat and the unripe herbage of scouring lands, and, he repeated, that it would be interesting to ascertain whether a similar difference existed in the pasturage of soils where splenic apoplexy occurred.

In conclusion, he would observe that the causes which produced scouring appeared to have some common origin with those which produced splenic apoplexy. In that view he might be mistaken; but it was certainly a fact that, on lias-clays, the produce did not get ripe, and, being consumed in an unripe state, it produced all kinds of diseases. It was a curious thing that manuring had an effect the very reverse of what they would expect on the scouring land of central Somersetshire; it made the evil worse. In a wet season, when one would expect to see the disease, it did not appear; while in a dry summer, when there was a very rapid growth of vege-

tation, it was most dangerous to put cattle on the land. It was in a dry summer that the meadows scoured most.

Colonel CHALLONER said it was an every-day question among farmers whether the water that cattle drank from a pond, into which the drainage of the farm-yard ran, was or was not detrimental. He would be glad if their chemical and veterinary professors could give them some definite information on that point.

Professor VOELCKER said many samples of water which looked like the very essence of the manure-heap had on analysis been found to contain but little deleterious matter. Indeed, such water frequently contained much less of such matters than clear water. It was a remarkable fact that some of the clearest, best-tasting, and apparently most wholesome waters were among the most deleterious that could be taken, being largely impregnated with mineral and saline substances. Amongst the latter he would mention especially nitrates as being highly injurious. In the yard-waters the amount of organic matter was often very small, a very small quantity of drainage being sufficient to give a brown colour to a large quantity of water. Water which appeared to be impregnated with a large quantity of organic matter was often not so in reality. When, however, a large quantity of refuse material found its way into pond-water it must be injurious.

Professor SIMONDS agreed with Professor Voelcker that the dark colour of water did not of itself prove that it was deleterious. There was a great deal of colouring matter in the farm-yard that found its way into the contiguous pond, and it was an established fact that cattle drank such water with impunity. Some cattle even preferred it—he would not say to their benefit—to harder, clearer, and brighter water. Whether or not such water acted injuriously or not to health depended, however, on the amount of organic matters in it. It might contain so small an amount as not to be prejudicial to the health of an animal, or, on the contrary, so much organic matter and saline substances might be mingled with it as to render it very deleterious.

Lord WALSINGHAM then moved a vote of thanks to Professors Simonds, Buckman, and Voelcker for their able and instructive lectures.

Colonel CHALLONER seconded the motion.

The CHAIRMAN, before putting it, said he was sure the council and the members present were much obliged to those gentlemen for the information with which they had favoured them; information which could scarcely fail to direct the attention of the owners and occupiers of land in similar districts to that which had been described—to the question whether, as regarded a great deal of such land, it might not be well if it were broken up, not necessarily for a permanency, but for a course of tillage; so that if it were again converted into pasture the present bad grasses might be superseded by grasses of improved quality.

The motion was then agreed to, and the proceedings terminated.

24

Δ
See 1510.7

THE
JOURNAL
OF THE
ROYAL
AGRICULTURAL SOCIETY
OF ENGLAND.

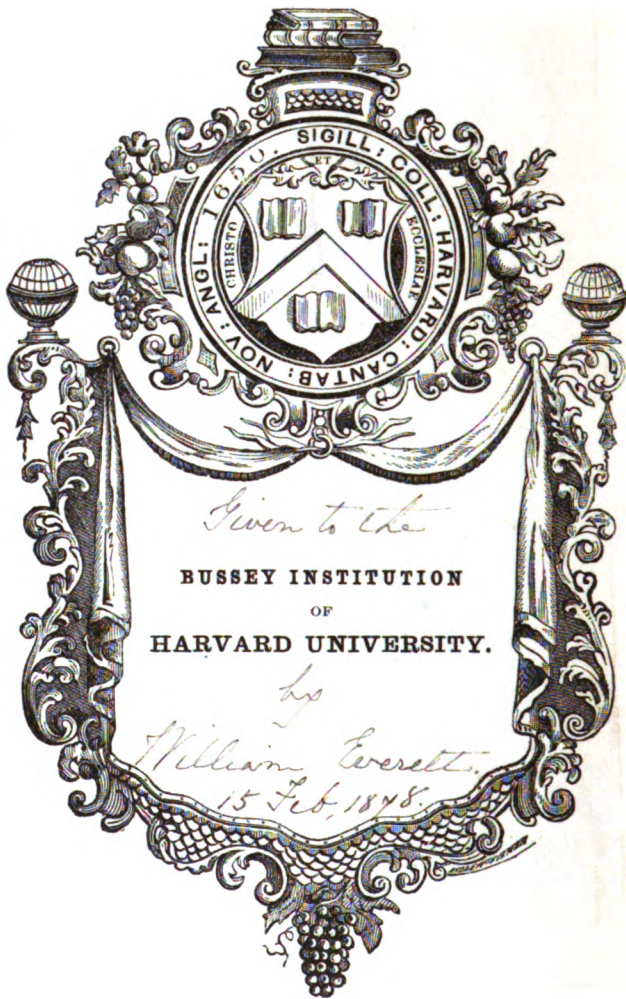
VOLUME THE TWENTY-FOURTH.

PART II.

No. LI.

LONDON:
JOHN MURRAY, ALBEMARLE STREET.

Price 6s.



XVII.—*On the Breeding of Horses—a Letter addressed to the Right Honourable John Evelyn Denison.* By W. DICKENSON.

MY DEAR SIR,

You have asked me to give you an outline of my experience in breeding horses, with special reference to my success with the cart stallion I imported from France, to the intent that it may be published in the Royal Agricultural Society's Journal. If you think anything I can state will be interesting to the members of the Society, I shall have great pleasure in complying with your request. I have been engaged with every class of horse from the winner of the St. Leger to the horse walking in the cart, and purpose to make mention of them all, except the race-horse, which I shall merely notice so far as he exerts a general influence for good or for bad upon our horses at large.

And first permit me to address some general remarks to those members of the Royal Agricultural Society who have had less experience than myself, and beg the indulgence of readers who may think that I enter too much into the detail of a subject with which they are well acquainted.

It is necessary to consider, before beginning to breed horses, whether the land designed for it is fit for the purpose of breeding sound, healthy animals. If it is, the starting-point is right—you have reason to hope for success; if it is not, it is far wiser not to make the attempt, but to buy in and sell out as quickly as is convenient. It is thoroughly well known that sheep bred upon wet, undrained, boggy soils, have defective constitutions; they have diseased livers, decayed feet, and inferior wool, and are so thoroughly unsound in many instances that they die in great numbers without remedy. Horse-breeding may be attended with similar risks, which should be steadily kept in view.

Horses should be bred upon a dry subsoil to make them sound in constitution, sound in wind, and sound in colour, by which I mean that whatever be the horse's colour, it should be a deep, not a faint one. The surface, moreover, should be fertile, abounding in carbonate and phosphate of lime, to grow horses of full size, with plenty of bone and muscle. Upon this subsoil and this surface, you may expect sound, full-sized, healthy animals. A wet, spongy, clay soil produces delicate constitutions, defective wind, pale colours, and large flat feet. If your land is not dry naturally, perhaps it can be made so by effective drainage; if it cannot, do not attempt to breed horses—every kind of disappointment will follow such a course. Neither are a very dry subsoil and very dry surface desirable, for these produce small animals with narrow, contracted feet.

The next step is to procure good mares to breed from; these should not be used because you have them, still less because they are unsaleable, but should be bought for this especial purpose, and selected with great care. I should advise their being bought in the autumn of the year, when two years old off, to be put to the horse in the following spring. I advise this because they are all brought to market at that time, the choice is greater, they are purchased at less cost, they are more free from defects, and also breed much better. They have never been made up, but are brought direct from the grass fields, which is very important as to soundness of wind and limb. No one has ever tried to breed from them, and sold them because they fail to do so; if they are unsuccessful in your hands, you can part with them at five or six years old, most likely at a profit.

It is important to have made up your mind fully what kind of horses you propose to breed before you begin to select the mares. They must be the very best of their kind, with the best action, and free from all defects of wind and limb. Such animals as are roasters, or who have curbs or curby hocks, spavins or splents, are unfit for the purpose. The toes should point in straight lines; they should not turn outwards, and had better not turn in. The feet should be of moderate size, not round, but of an oval shape. Convex soles are particularly to be avoided. The excess of substance should be on the side of the mare, she should be made useful on the farm; the blood on the side of the horse. Where elegance of appearance and speed are to be combined, or either to be had, it must come from the thoroughbred side. Weight and substance come from the cart, but elegance and pace from the blood. There is no substitute for blood where pace and continuance are required.

As I have begun saying something about the stallion, I will just observe with what care breeders of cattle select their bulls, not only looking well at every line of their bodies, but at every feature of their faces; their width, their length, their colour, and their touch must be approved, and even their ancestors for many generations are taken into consideration. Rams are just as closely inspected. In both cases the action must be good; they must stand straight upon their legs, and be able to move with ease to themselves. Breeders of horses would do well to use as much care in selecting stallions for their mares, but I am disposed to think they do not. It is not unusual to avoid the trouble, and put the mares to some convenient horse. Economy sometimes suggests that "this horse is only one or two pounds, he is just as good as the absent one, whose price is perhaps double." Another very important feature is to be observed. Breeders of cattle and sheep keep their best females to breed from—the better they are

the longer they are kept; with horses, the better they are the sooner they are sold, not even the very best young mares being reserved for the stud. Those that cannot find a customer are too frequently kept and bred from; it is not an unusual saying with disappointed breeders, "If I cannot sell her I will put her to the horse."

Great advances have been made in the breeding of cattle, sheep, and pigs, in every part of the United Kingdom during the last 40 years. What is the case with regard to horses? Have they not retrograded in the same degree? Can the present race of horses be compared with those bred 40 years since? The cart-horse, perhaps, is the only class that can bear the comparison. There is a cause for all this, which I shall mention hereafter.

Here I close the general remarks, and proceed to mention the cart-horse I imported from France, with the result of my practice. I fancy some of my readers saying, What induced you to buy a French horse? Could you not find one good enough in your own country? My answer to those persons is, Yes, I could, and did so. I bought what I thought, and others thought too, a splendid horse; I bred from him, and so did my neighbours, very good horses; and I should have continued thinking there were no better cart-horses in the world than the English; but in 1855 I went to the International Exhibition in Paris, where I had sent some short-horned cattle. There my attention was attracted to a class of horse I had never seen before. I looked at them and was astonished, seeing them drawing great long carts, as long as the English waggons, loaded with immense blocks of stone (not as ours are loaded in London, with two or three blocks), walking nimbly away the whole day from the pit to the building. These immense loads of stone made me think of the three or four dray-horses drawing at a much slower pace a few butts of beer through the London streets. These horses, walking so nimbly with these great loads of stone, were not so fat as our own favourites, but they seemed to me to be doing twice the work. Although leaner, they bore the strictest scrutiny; the more I saw of them, the more I admired them. Meeting Mr. Jonas Webb, I called his attention to them. He said he had never seen such before; he had observed a horse taking into the show-yard an immense load of provender for the cattle, that astonished him beyond measure; he had resolved to try to buy him, but he lost sight of him that day, and never saw him afterwards. I thought them so superior to ours, that I resolved to buy one to take home. Very much to my disappointment, I could not find one young enough and good enough to buy. I saw them every day at their work, but none for sale. I went through all the dealers' stables

without succeeding. I furnished myself with all the information to be obtained as to fairs in my way home; to some of which I went, and found, just as at our common small horse fairs, not a good horse in them. I happened to stay a day at Rouen, when the pavement of the bridge was up, over which great loads of goods had to be drawn to the quay; there again I saw these horses coming with their great loads of goods, which they could not draw through the mud more than a few yards at once, drag themselves almost to the ground, and I never saw one refuse to draw again and again.

This confirmed my resolution to have one of them; so I made an arrangement with a principal dealer in Paris, and in 1856 bought the horse I call "Napoleon," which Mr. Denison has asked about. I have never once regretted the purchase. He has been worked on my farm ever since, almost always with mares. I have never had so good, quiet, active, and powerful a horse before. In no one instance has he given us any trouble. He is unlike our English cart-horses, for with great size (16½ hands high) and immense substance, he shows a dash of blood. He has an Arabian head, not small, but of fine character, well proportioned to his size. The neck is very muscular and well turned, the shoulders large, very deep, without lumps on the sides, and oblique, such in shape as would not be objected to for a riding horse. The bosom open, the fore legs magnificent and very short, with great bone, hard sinews, and with little hair upon them. His feet are perfect in shape, and perfectly sound in work; his back short, rather dipped, round-shaped ribs, large loins, rather plain drooping hind-quarters, very large thighs, low down, and tightly joined together with prodigiously powerful clean hocks, and very short hind legs, well under him. We never have had a difficulty with the engine or thrasher, or with anything in the mud that Nap. could not extricate us from. His stock are as good and kind as possible. It is a saying with the men, that Nap.'s colts want no breaking. My mares are small and active; the stock are considerably larger than the dams, but so cleanly, that as foals they look more like carriage horses.

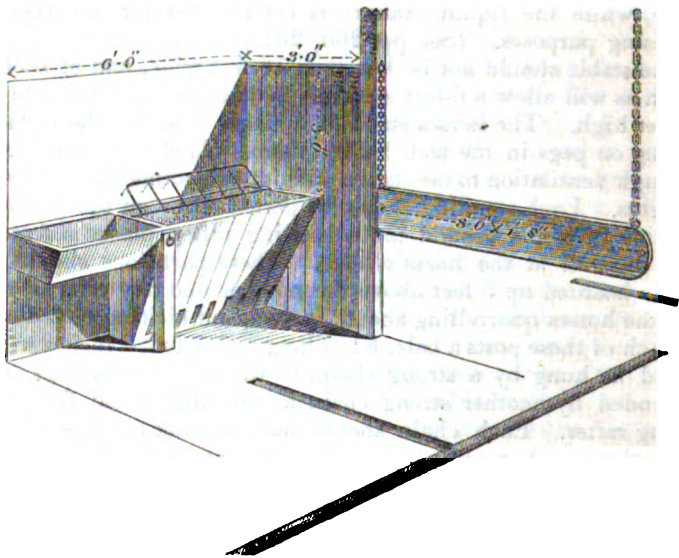
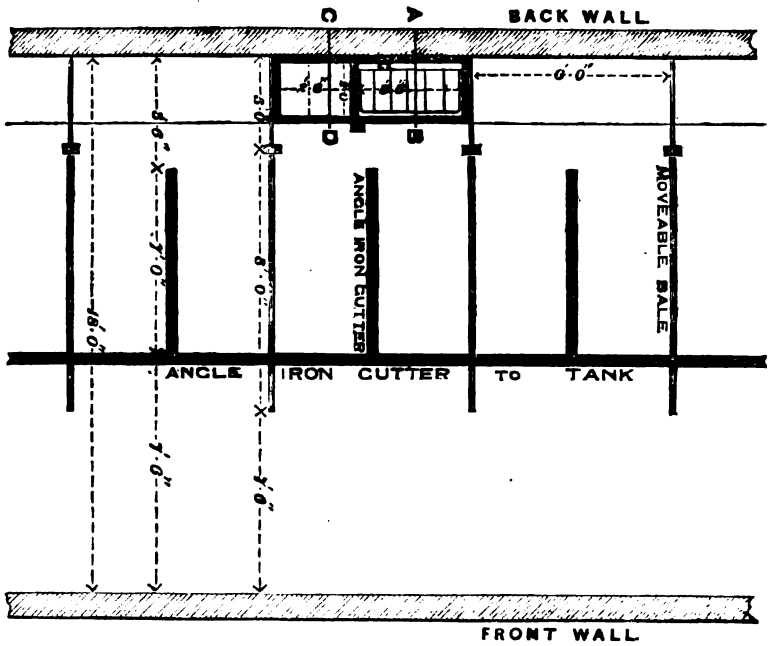
I think the cart mares to work and breed should be of moderate size, from 15½ to 16 hands. They should be long, low, wide, and handsome, compactly made, with short backs, arching downwards, and with wide, table-shaped loin. The legs should be short and clean, the bone large, especially behind. They should be good walkers, and as I recommend working the mares on the farm, the high stepping action must not be overlooked. The mares should not be put to the horse to produce foals before the grass comes in May, when the work of the farm is very much abated, the mares can be spared

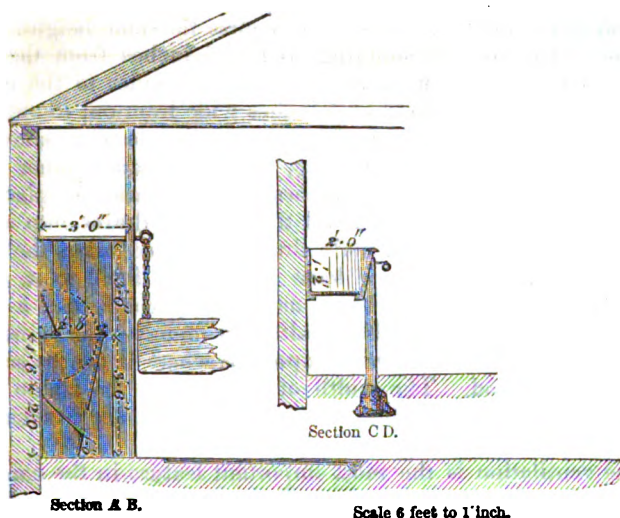
for a short time, the grass will be convenient for the milk, and the weather warm for the foals. These will do well with the mares at grass (after being kept in for a few nights) till the autumn. I work my mares moderately, up to the day of foaling, and I think it assists the operation; but they should not be put to snatching, distressing work. When the foals are weaned in the autumn, they must have shelter, and be well kept. A few oats, cut roots, cut hay, and a little bran, will do well for them till they go to grass again in the following summer, during which time the colts must be castrated. In the winter they may again be kept in the sheds. They should never be allowed to get poor. They will be useful at three years old, and do half the work of horses, if kept in a cool, well-ventilated stable.

I have just read some observations made by Mr. Ruck, in the course of his recent lecture upon steam cultivation, delivered before the Royal Agricultural Society. He describes the inconvenience he has suffered from the illness of his farm horses, which appears to me excessive when I compare it with my own experience. I will therefore detail with some minuteness how I think such misfortunes may be avoided by gentlemen equally unfortunate with Mr. Ruck, who are compelled to employ horses in consequence of their farms being too small to allow of the use of Mr. Fowler's steam-tackle.

With the aid of three illustrations I will describe the stable in which the cart-horse can live healthily, consume his food without waste, while the liquid manure is economised for the highest fertilising purposes. (See pp. 260, 261.)

The stable should not be less than 18 feet wide, and of such a length as will allow a 6-feet standing for each horse. It should be 10 feet high. The horses stand in a single row, and the harness is hung on pegs in the wall behind them. This width admits of thorough ventilation to the stable, without subjecting the horses to draughts. Each standing should be parted off by an upright post reaching from the ground to the ceiling rafter, placed 3 feet off from the wall at the horse's head. These partitions should be closely boarded up 3 feet above the manger and hay crib, to prevent the horses quarrelling about the food, and kicking each other. To each of these posts a bale, 8 feet long and 1 foot 8 inches wide, should be hung by a strong chain, to divide the standings, and suspended by another strong chain at the hinder end from the ceiling rafter. Each chain should have a hook and eye within reach, that may be readily unfastened. This arrangement will leave a space of 6 feet opposite the head of each horse, available for feeding purposes. The manger for corn and chaff may be made 2 feet 6 inches long. It should be 2 feet wide at the top; 1 foot





2 inches at the bottom. The hay and straw, which should be cut into 6-inch lengths, will require a larger receptacle, which should be 3 feet 6 inches long, 2 feet wide at its upper part, and half that width below. It should be so constructed, that while even with the manger above, it should reach to the ground, 2 feet above which should be fixed to the wall a bottom, sloping to 1 foot above the ground in the front, where some upright openings should be cut, so as to admit of the escape of the seeds and dirt.

At the top of this hay and straw crib, an iron rack with bars 6 inches apart should be so hung as to open up and fall back against the wall to let the fodder be put in, and then be put down upon it for the horse to eat through. It should be so much smaller than the opening that it can fall down with the fodder as it is consumed, by which means not a particle is wasted. The manger may be constructed of yellow deal $1\frac{1}{2}$ inches thick for the front, back, and ends; the bottom of slate three-quarters of an inch thick. The top of the front and ends should be covered with half-round iron, $2\frac{1}{2}$ inches wide, screwed on to project over the front outside a quarter of an inch, and three-quarters of an inch inside the manger. This prevents the food being tossed out, and the manger being gnawed. A short post must be put up as near the centre of the standing as possible to support the manger, into which a large screw ring must be put to let the chain or rope of the headstall pass freely up and down without

constant friction. The manger may be 3 feet 6 inches from the ground to the top; the hay-crib of course the same height.

The paving of the standings 3 feet 6 inches from the head should be flat, then with a fall from both sides to the centre, where an angle iron drain of 4 inches wide from out to out, with a removable flat iron cover fitted to the inside of it, should be placed straight down the standing, with a fall into another larger cross main drain 10 feet 6 inches from the head, so placed as to carry away the urine from all the smaller drains into a tank outside the stable. This main drain so placed takes the urine from the mares, and has a loose cover also fitted to it, easily removed for sweeping out when necessary, perhaps once a week. This system keeps the stable healthy, economises the urine, and the straw also, the latter very important where it can be sold, or consumed as food. The width of 18 feet for the stable gives room for narrow corn bins 3 feet high, so that each carter may have his horses' corn separate.

The ventilation is the most important feature in the construction of the stable; upon it depends the health of all the horses, and consequently their usefulness. No stable should be without a constant change of air, and no horse in it should feel the draught. The two ends of the stable may be so contrived as to effect this object in this manner. Take 12 feet from the head wall to the opening for the stable-door; allow 8 inches for the two door-posts, and 4 feet 6 inches for the door. This will leave 10 inches between the door-post farthest from the horses and the back wall. This space, from the ground to the top of the door, should be left open, and covered with strong rabbit wirework, which should be permanently fixed. The door should be 7 feet high, and cut into two parts, horizontally, at a height of 4 feet. The lower part may be kept shut while the horses are in; the upper 3 feet may be open or shut, according to the state of the atmosphere. Mine are seldom shut, except the wind is blowing heavily in; we then close that end. There is another communication with the outer air between the door and the ceiling. The opening may be 3 feet long, and so placed that one end is against the back wall. It should have zinc, perforated with a quarter-of-an-inch hole, permanently fastened over it. This arrangement will keep the stable sweet and the horses healthy. I have no communication from the stable to the loft above for any purpose, as I have learnt by observation that this promotes draughts which are highly injurious to the eyes. The stable should be ceiled, for the convenience of lime-whiting. Plenty of light should be admitted from the hinder wall, by narrow fixed windows here and there, made of slabs of strong glass,

never to be opened. Windows opening in bad directions, and open skylights, kill horses by wholesale. The arrangement I have described is suited for ten horses.

Where 18 feet cannot be had, 17, or even 16, may be made to do, by taking 6 inches from the width of the door, and the rest from the space between the door and the head wall.

It is important that the water—of which cart-horses are allowed to drink about as much as they like—should be exposed to the atmosphere at least six hours before they are allowed to have it; and they should never be allowed to drink till they have eaten something. The colic (commonly called gripes) is almost always occasioned by their taking large quantities of cold water into empty stomachs.

Cart-horses, more particularly than any others, are subject to greasy heels and farcy legs, the treatment of which I leave to the veterinary surgeon; but my experience has taught me that in almost all cases they may be avoided, by not allowing the farm-servants to wash them in the pond nor in the stable when they return from their work. Neither of these operations would produce the disease if they were rubbed dry immediately, but as it is impossible to get this done, I have stopped the washing entirely; if the dirt cannot be rubbed off, I allow it to remain on and dry upon their legs. The adoption of this system many years since has completely prevented the occurrence of those diseases.

The temperature of the cart-horse stable should be as little above the external air as may be, to keep the inmates comfortably warm. You should never feel, nor smell, that you are in a stable. The working cart-horse, when turned out to grass in the summer, may have in the stable 8 or 10 lbs. of bruised oats mixed with a little hay and straw cut together into chaff. In the winter time he will consume, entirely in the stable, of bruised oats 10 lbs.; of hay and straw cut together, 7 lbs. each; of cut roots 28 lbs., given with the oats and chaff. This style of feeding will cost in summer about 11*d.* per day for each horse, besides the grass, and 1*s.* 2*d.* per day in winter. When roots cannot be had, 1 lb. of dry bran to each horse per day may be used instead. When horses work excessively, a small quantity of split beans may be given in addition, but I do not advocate this; I do not like beans for cart-horses, and very seldom indeed give any.

I have now done with the cart-horse, with which I am sure I have severely taxed the patience of my readers, and proceed to another kind of draught horse, the like of which I think I may safely say there is not in Europe, if there be in any part of the world, the London carriage-horse. I need hardly say how much

I admire them ; I feel sure everybody everywhere admires them as much as I do. It is the breeding of them of which I am to write, not of themselves. My observation and experience in breeding them induce me to think they are more surely bred, more easily sold, at an earlier age, with less trouble and more profit, than any other class. They may be bred, too, from mares that can do the work of the farm thoroughly well. The Cleveland bay, the Scotch gray, and the Clydesdale mare, put to the good thorough-bred horse, will all breed capital carriage-horses for the London market. If the mares are well selected, and the high-stepping action not overlooked, very valuable horses indeed may be thus produced. Where this is aimed at, more attention must be paid to fine heads and necks than is necessary for cart use. Thorough-bred mares breed first-rate horses, put to a good cleanly three-parts-bred cart-stallion. The young stock intended to come out early, at three years old off, must not be neglected in their early keeping ; if they are, force-meat must be had recourse to, and then follow the strangles, distemper, roaring, lameness, &c., &c., which I need not parade before my readers, who are in some instances too well acquainted with them, without, perhaps, having ascertained the cause.

Before concluding with draught-horses, I must not omit to mention what appears to me an important guide in selecting horses for their different purposes. They all have either to draw or carry weight—two distinct purposes. The line of the vertebræ indicates to which of these purposes they can work with advantage to themselves. If the backbone is arched downwards, they cannot *carry* weight. If it is arched upwards, they cannot *draw* weight. The horse to carry, should have the arch gently upwards ; and the horse to draw, should have the arch gently downwards ; in other words, be rather hollow-backed. It took me a great deal of time and trouble to discern this, and I am anxious to impress it forcibly on my readers. I observed that my horses working in harness with low backs were in good condition ; and those with high backs, poor. I saw the fact, but for a long while could not ascertain the cause. What is the cause of this ? is a question I put to myself as constantly as I observed it. At last the answer came, "The bridge that was so strong one way, was equally weak the other." I wish to illustrate this more clearly to my readers. The bridge arched upwards, will carry almost any weight you can place upon it ; turn it upside down, and it can carry scarcely any weight at all. If the horse has to carry weight, and the backbone is arched upwards, it is in the position of the greatest strength ; on the other hand, if the horse has to draw, the forces brought into action will tend

to press the spine upwards, and therefore a downward curvature is the most advantageous formation. Horses with high backs cannot push heavy weights back, for the same reason; the backbone, already bent up, is forced upward still more, the arch is opened, and power is lost. The horse with low back, if willing, can push back almost any weight, because the weight is pressed against the lower side of the arch; which, being bent downwards, is strengthened by the pressure. Should my explanation not appear clear to my readers, I advise them to put into the plough, side by side, a horse with a high back, and one with a low back, and observe whether the high back does not bend up higher by his work, and whether the low back does not remain in its fixed position. That which bends is weak; it cannot bear the pressure upwards. The horse would say at the end of his day's work, if he could speak, "How my back does ache!"

The fixed position of the vertebrae indicates the power of the brute as well as the power of the man; the loose, wabbling back cannot endure in any animal.

The carriage-horse is expected to make a handsome appearance, carry his head high, his knee well up, and to rely entirely upon his driver where he is to go to an inch. He is partly blinded by the blinkers, and very much prevented seeing his way by the bearing-rein. Not so the riding-horse; his eyes are unmasked, his head at liberty to pick his way for himself and his master too. While the carriage-horse is looking up to the drawing-room window to be admired by the ladies, the riding-horse should be looking where his next foot is to be placed upon the ground to give confidence to the rider. His neck should be lighter, and capable of being easily arched. It is very disagreeable to me to have a high stand-up harness neck before me. I prefer a light neck, not very long, and shoulders so long as that, when I am on his back and he in a trot, I can see his knee at work before me. This gives the rider a good seat, and places the weight well back upon the horse where he can carry it. The hind legs should be well under him, the fore legs short, feet sound, the hips low and flat: wide, high hips are ugly, and objectionable in all horses.

It may be accepted as a rule, "that the horse that walks well, can either trot or gallop well;" not unfrequently both. The best hacks I have seen have been bred from good strong pony mares and thorough-bred horses. You cannot have too much blood in your riding-horses; but less can be done with in the hack than in the hunter, in whom pace and endurance are wanted, besides particularly good wind, and also round action, to accommodate himself to ridge and furrow, and carry his master safely home

after the sport of the day. The same shape as for the hack is the perfection of shape for the hunter; but a little more length, a little more size, and not less than three parts blood, will be required to go in a good place with hounds: 15·3 to 16 hands is the perfection of size, and quite thorough-bred is the perfection of breeding. The back should be particularly good, the hind legs short, and well under the weight to be carried.

The drainage of the stable of the cart-horse, carriage-horse, hack, and hunter, can all be carried out in the same way with advantage to them all alike: the mangers and hay-cribs should be constructed as already described.

Instead, however, of dividing the standings with bales, as with cart-horses, it is better to have boarded partitions, enclosing stalls six feet or six feet six inches wide, and ten feet long. The ventilation should be arranged upon the same principle, with a fixed amount of inlet and outlet, in addition to which another portion, under the control of the head of the stable, may be made available according to the variations of the atmosphere. Horses doing fast work and light of flesh, will bear more warmth than those working slowly. The stable should never be without a change of air. The temperature should never be above 60° Fahr., except when the external atmosphere is above it. Every hunting establishment should have a hot-water apparatus, a plentiful supply of water, and a bath-room to wash the horses in as soon as they return from the field. Loose boxes, sixteen feet square, are absolutely necessary in every horse establishment; some of which should be separated from the others for sick horses. I have said something about the necessity of blood in the breeding of horses, but, knowing what I do, I never think I have said enough. I have hinted at the great difference between the want of care and attention taken by the breeders of horses in their selection of stallions as compared with that taken by the same class of persons breeding cattle, sheep, and pigs, and think I have not overstated the truth. Every person who has seen the great change which has taken place in the quality of the animals produced throughout England, Ireland, and Scotland (horses only excepted), will admit that the improvement of them is marvellous; while horses alone have become deteriorated almost in the same degree. Why is this? It is because they have all had more care bestowed upon them: the production even of pigs has been more actively cared for than the breeding of thorough-bred horses (except by racing men for racing purposes). It is simply because the breeders of the inferior animals, since the establishment of Agricultural Societies, have been well rewarded with prizes, while the best thorough-bred horses in England, the most

important class to our national welfare, have been very much neglected. The prizes given to every class of bullock, sheep, and pig, male and female of every age, have so far exceeded those given to thorough-bred horses, that the latter have not been worth competing for. That is not the only reason; there is another important one. It is that formerly the Royal Plates of 100*l.* each were given for competition all over England for four-year-old horses carrying 10 stone 4 *lbs.*, five years old, 11 stone 6 *lbs.*, six and aged, 12 stone, and decided in four-mile heats. These prizes were a great inducement to breeders to endeavour to get horses of size and substance, and to keep them when got. As long as these Royal Plates were given to horses carrying these high weights, strong thorough-bred horses were bred and kept, which in the end broke down, and became the most valuable acquisition to breeders of horses in all parts of the country. Having become blemished, they were no longer desired by foreigners, and continued the remaining portion of their lives at home, helping to produce a race of horses with size, substance, blood, and action. From their stock the most valuable hunters, hacks, and carriage-horses were selected, and from the less well-favoured the cavalry was especially well mounted.

Our horses were then the envy of the whole of Europe. These Royal Plates for high weights and long distances brought up our horses to this point of excellence: so long as they were so given, so long we kept our supremacy; but, by some unfortunate influence, the conditions were altered, and lighter weights and shorter distances allowed. From this point I date, under my own observation, the commencement of the deterioration of our thorough-bred horses, and consequently of those of every-day use. I saw the commencement of the evil; I now see the consequence. There was no longer any inducement to breeders to retain their great strong two-year-old colts; they could not run at that age, neither could they at three years old struggle with moderate-sized horses. The best horse ever produced in England could not race at two nor at three years old; he was not only the fastest and the stoutest of any period, but he was one of the most powerful—this horse was Eclipse. If he had been of these days, in all probability his fate would have been sealed at three years old; he would have been sold as a great slow brute to some foreigner, coming among us to make such purchases at a small sum, as most of our large-sized, unfurnished horses have been, till there is hardly one left. Since there is nothing further to run for at four years old, they must be sold. I can speak positively from my own knowledge to this state

of things; the alteration of these plates and other Turf arrangements have combined to produce quite another class of race-horse—a slippery, slender, small horse, that comes quickly to perfection, and as quickly passes away.

The adoption of handicaps at all country races is another evil; nearly all the important races are handicaps, instead of weight for age. This tends to make all horses equal, and give to all, good and bad, an equal chance of winning: speed is substituted for substance; horses are tried at two years old for speed; if slow they are cast, and the expense of training stopped. This promotes sport and produces betting; and therefore answers the purpose of sportsmen, but it is ruinous to the national supply of horses. Sportsmen are anxious to make their own game; they do make it by these means, but the national interest is not served. The nation should take care that the nation's horses are not ruined by giving money to produce that end. The Royal Gifts were bestowed expressly with the national object of improving our general breed of horses, which was brought to a high state of perfection by the means used. The conditions of the plates were altered, we have failed in our aim, and now have two classes of horses—blood horses without substance, and strong horses without blood. Both are bad for common purposes. We want the combination of strong blood horses with the country mares of all kinds. We shall get it by retracing our steps and returning to the old plan—the Royal Plates for four-year-olds, 10 stone 4 lbs. for five, 11 stone 6 lbs., six and aged, 12 stone, not four-mile heats, as of old, but one four-mile race. This, I think, must be the starting-point, if we are ever to recover our lost position for fine strong blood horses. Nothing can be expected from Turf arrangements; wretched as the system is, of making good and bad equal, and destructive as it is to the quality of our horses, it does promote sport, and it does produce betting—the final object of keeping race-horses. It would be a great stimulus to the recovery if His Royal Highness the Prince of Wales (who well knows the value of blood in horses ridden across the country) were to add some Royal Plates for the same high weights, varying the distance to a race of three miles.

The money given by Lords Lieutenants of Counties, the Members of Parliament, and for town-plates, should all be given with the national interest in view, and this would assist very much to expedite the improvement. This should be followed up by Agricultural Societies' prizes for these horses, as though they were of equal importance with cattle, sheep, and pigs; prizes should be given for thorough-bred horses of three, four, five years,

and aged horses, such as have served mares during the season as country stallions, at a country price: blemishes should not exclude; but only lame feet, unsound wind, spavins, and curbs, all of which may affect the rising generation. Prizes for geldings seem to me to be unnecessary, and can have no effect upon the object required.

When a prize of 100*l.* was given by the Royal Agricultural Society at Battersea, the best stallions were brought from all parts of the country—even a Derby winner, to whom was awarded the prize. Nevertheless, the object of the Society was not obtained. It is not a winner of the Derby or St. Leger—a horse that will never be taken from his own stable door—that should come to an Agricultural Show, exhibit himself there, and walk off with the prize; but it is a good strong thorough-bred country stallion that is available for the use of the ordinary mares of the country. This prize did, however, indicate a great fact; a hint suggestive of what may be done by the 100*l.* prizes towards restoring our losses, and bringing us back again to our original position. It has illustrated the great principle that such rewards are highly esteemed by the owners of valuable horses, and will induce them to keep them to show for such prizes; and there surely is great need of them. The country is so ill supplied with thorough-bred horses that it is almost impossible to find a useful short-legged thorough-bred horse that can carry 12 stone across the country. This loss is immense; there is no substitute for blood; there is no elegant carriage-horse without it, no good quick-stepping hack without it, and no fast, enduring hunter without a great deal of it. The anxious breeder, who knows the value of it, will say, "Where am I to find it?" I must admit that this is very difficult now; it was not so a few years since. Blood-horses have been getting worse and worse. Great studs of such animals were formerly kept; and many of them, too, in my recollection, all over Yorkshire, as well as in many other counties: they occasionally won a Derby, and not unfrequently a St. Leger. Those that were not so fortunate carried their masters with hounds; carried their masters' huntsmen and whippers, and made valuable country stallions. Those bred now are light, weedy, powerless and worthless in every national point of view.

Our cavalry must feel this wonderful falling off. If they should be again brought to contend with some hostile power, it will be seen that although we have not lost the steel of our men, we have lost the energy of our horses. Let it not be overlooked that blood gives pace; pace is power. Blood carries weight; it is said that a thorough-bred horse carrying 32 stone for four miles beat the best and strongest horse that could be found, not thorough-bred.

Blood gives life; the thorough-bred horse lives longer in work than any other. Our horses have fallen off wofully since the battle of Waterloo; and those of our friends now, who were opposed to us then, have been as much improved as ours have been deteriorated. The Emperor of Russia also has so improved the horses of his Imperial Guard that I believe he has 10,000 men better mounted than any 10,000 men in England or anywhere else.

The remedy is in our own hands. Let Her Majesty's Plates of 100*l.* be re-established for high weights and long distances; let the Prince of Wales throw his influence into the scale, and the nation follow the example,—it is a national subject, and worthy of all the patronage that can be bestowed upon it. The Agricultural Societies of the United Kingdom should follow on with the Royal Agricultural Society, and call for weight-carrying, thorough-bred stallions. We may thus recover what we have lost, and again possess some useful animals capable of doing good service to the country.

Be it ever remembered that, however bad may be the horses available for the general use, those upon which the cavalry are mounted will be worse still; whilst, if horses at large are better bred, the army will be better supplied. I have sent six mares fifty miles to a thorough-bred stallion that I saw at Battersea. I would advise any anxious breeder to look at those exhibited at the Royal Agricultural Show, with the view of selecting one for his purpose for the ensuing year; there are a few left; but they are very few indeed.

In conclusion, let me remark that most of the observations and opinions which I have expressed have not been adopted at random as chance suggested, but have resulted from what may be called the statistics of the stable. It was my habit early in life to keep in a book for the year a detailed account of every horse I bought, his age, pedigree, colour, quality, defects, and native district, number him, and give him a name significant of the horse as far as possible, to impress him on my memory. These were all entered when he was bought, and the chief incidents of his career were added from time to time afterwards. At the end of the year all these circumstances were brought together and formed a summary of the year's transactions, consisting of—

The horses bought in.

The horses cast and sold out; why each was cast and sold.

Those killed accidentally; how killed.

Those that died; the cause of death, and where.

At the commencement of the new year all those horses remaining in stock were re-entered by my own hand in a new book, which stated in whose possession they were to be found, with every important particular attached to them for further observation.

As the list always contained several hundred horses, a great mass of evidence grew out of it, which often forced upon my notice views which I had by no means anticipated. Such views, properly grouped and recorded, confirmed by subsequent observation, may be considered as the legitimate laws for the breeding and management of horses, based upon what our neighbours call the logic of facts. And here I will mention one case in particular as to the comparative duration of life of horses. Apart from accidental circumstances, they live longer in the same kind of work, in proportion as they are employed at a pace below what they are capable of going. "Pace kills," is an old proverb, and is equally true as it is old. The cart-horse working in a cart is old at 16, and dies out generally at about 20 years of age. The coach-horse, doing the same work, is old at 20, and finishes his career at about 25. The race-horse working at the same pace will work till 30 and sometimes till 35 years old. Each class must be understood to draw weights in proportion to the weight of the horses. I note these circumstances because I consider, first, that the value of my opinions depends upon their origin; next, because I hope that others may be induced to follow up the same system of observation; and lastly, to give an instance showing how every careful record of facts becomes a substantial contribution towards the advancement of knowledge.

If by my advocacy of this cause I should produce such a change in the system of breeding horses as to recover the size and substance of the thorough-bred horses of the last century, I shall have the pleasure of feeling I have done my country important service.

XVIII.—*On the Reclaiming of Waste Lands as instanced in Wickwood Forest.* By C. BELCHER.

PRIZE ESSAY.

THE term "Waste" is sufficient to arouse the attention of every thoughtful person. In manufactures and arts, matter which for ages had been considered worse than worthless, has, by the ingenuity of man, been turned to useful purposes, and in many

instances caused a great increase in the comforts and luxuries of the human race. These facts are of themselves encouraging to everyone whose thoughts turn towards agricultural improvements. Did space permit, perhaps it would be interesting to inquire the reason why, in the present day, we have *any* waste land in England, and why it is that some of the surplus capital of this great country, which appears to flow so freely towards any new scheme that offers the slightest chance of profit, has not been applied on a *very large* scale to the thousands of acres that at present lie almost barren and uncared for. According to the best authorities on the subject, there are in the British Islands some 20,000,000 acres of waste land! Of this number 4,000,000 acres are said to be capable of profitable cultivation by plough or spade, and 8,000,000 acres, though not likely, in consequence of their peculiar situation, ever to bear *corn* with advantage, might still be rendered fit for the pasturage of cattle and sheep. Such being the case, perhaps, an account of what has recently been done in the way of reclaiming a large tract of land belonging to the Crown, may have a general interest, and may possibly stimulate some owner of waste land to commence such a work of improvement himself, or by a long lease and liberal covenants, to induce an enterprising tenant to embark the necessary capital on a similar undertaking.

In the year 1853 an Act of Parliament was passed for the disafforestation of the ancient forest of Wichwood. Under this Act a considerable tract of land has been reclaimed; and it is the object of the following pages to describe the various operations by which one large portion of this land (the Queen's allotment) was brought into cultivation; to give an account of the expenses incurred; to make some remarks on this clearance in particular, and also some additional observations on the reclamation of land generally.

Wichwood Forest and the Disafforestation Act.—By referring to a map of Oxfordshire, the reader will see a large portion of the S.W. corner marked Wichwood. It was a Royal forest, and comprised an area of 3778 acres. It was stocked with deer (principally the fallow deer), and was subject to the rights of the Crown, the hereditary Ranger, and a number of commoners, in the year 1853, when an Act was passed for its disafforestation. Three Commissioners were appointed to carry it into effect; they were Mr. Serjeant Channell (now one of the Barons of the Exchequer), Francis Offley Martin, Esq., and Nathan Wetherell, Esq. These gentlemen appointed Mr. Thomas Smith Woolley as their valuer, and Mr. William Brian Wood, of Chippenham, Wilts, as their surveyor. John Clutton, Esq., of Whitehall

Place, London, acted as the surveyor to estimate the rights of the Crown.

Survey of Wichwood Forest.—By the survey then made, it appeared that the forest contained—

	Acres.	Roads.	Poles.
Nineteen coppices	1804	1	27
Open forest, much covered with timber and brushwood	1766	3	12
The lodges with their enclosures	195	3	33
A few small encroachments	11	1	39
Total	3778	2	31

Public Roads.—The Commissioners first made public roads, and these were well placed for the convenience of all parties interested. Their whole length amounted to about 10 miles, and the cost of their construction, with a boundary-wall on each side, to 6985*l.*—nearly 700*l.* per mile. This may appear a small sum for such work; but the abundant supply of oolitic stone in the district rendered it sufficient for the purpose. The whole cost of these roads and walls was defrayed by the proceeds of the sale of outlying portions of the forest land, in accordance with the Act of Parliament.

The roads were laid out 30 feet in width, the centre track 15 feet wide, and where necessary the soil from this part was removed to a depth of nearly 2 feet, and a good foundation of rough stones put in, on the top of which broken stones were placed with a proper slope to each side; the price paid for making these roads, including digging the stones (and cartage where required), ranged from 3*l.* to 4*l.* 8*s.* per chain. The walls were also built by contract; the price for building, digging the stones, and cartage, was 24*s.* to 26*s.* per chain, for the ordinary height of 4 feet 3 inches. In a few places, such as deep cuttings, the walls were much higher, and the cost was proportionately larger.

The Award and the Crown Allotment.—As before stated, Wichwood Forest was subject to the rights of the Crown, the hereditary Ranger, and a great many commoners; probably some of these latter had established themselves through long custom, and neglect in past ages. Before the award was finally settled, every claim was carefully and thoroughly examined by the Commissioners; and though it could not be expected that every claimant would be satisfied with their decision, yet it is generally acknowledged that no work of such magnitude was ever completed where the parties interested had less cause for discontent.

On the 13th of July, 1857, the award of the Commissioners

was executed; by it the Crown acquired an allotment of 2543 acres; this was subsequently increased by purchase and otherwise to 2937 acres. Of this portion about 1970 acres were unreclaimed forest land, dense, dark, and gloomy; its silence seldom disturbed, except by the axe of the woodman, the gun of the gamekeeper, or the stealthy tread of the deerstealer. The clearing of this land was commenced in October, 1856, and completed in January, 1858, all in the short space of one year and four months, at a cost of 5815*l*.^{*} It is to the clearing and reclaiming of the Crown allotment that this report has reference. Many other smaller portions of the forest land have been brought into cultivation with various degrees of success, according to the different modes of management adopted by the numerous occupiers.

Herd of Forest Deer.—The first thing to be done was to get rid of the deer, of which from time immemorial extensive herds had been kept in Wichwood; and doubtless England's monarchs had often led the chase here, followed by attendant nobles, amid a chorus of horns and hounds; sweet music to the ear of the hunter; but as we have to deal with common matters of fact, we must leave such scenes and times to be recorded and depicted by poets and painters.

The Commissioners' order had gone forth against the deer, "let not one remain." Some few were caught alive in nets, and taken away to stock distant parks; but by far the greater number had to be killed, and to effect this purpose, the keepers were fully employed; to assist in the slaughter, guns and gunners came from the surrounding neighbourhood; and many a sportsman, whose largest game had hitherto been blackbirds, could afterwards boast of the number of deer that had fallen to his fowling-piece!

As a complete clearance was to be made, bucks, does, and fawns, in season or out of season, shared the same fate, and the taste of venison^{*} was known in *cottage* as well as hall.

Clearance of Brushwood and Timber.—After all the deer had been removed, the clearance of timber and brushwood began; no man able and willing to work was rejected. Hundreds and hundreds of men and boys were engaged, some cutting the light wood and laying it in drift, some tying the firewood into faggots, some preparing the larger pieces for posts and fencing, and others busy felling the timber trees, or stripping off the bark. Gradually and steady was the advance, like that of an invading

^{*} This sum does not include the cost of felling the large trees; a cash account of that work will be found in another page.

army; such an army, however, as might have been looked on with pleasure, even by a member of the Peace Society. It was heralded by the rustling sound of the brushwood, and the crashing noise which echoed through the glades when some spreading oak, a forest sire, fell prostrate, and intimated that the sylvan glories of old Wichwood were drawing to a close.

Timber and Tree-throwing Machine.—Many of the smaller timber trees and larger bushes were pulled down by Fowler's tree-throwing machine, which did the work quickly and effectually. This machine consisted of the horse-tackle, windlass, drum and rope, of a draining or mole plough. The wire rope was run out to a considerable length, and from it branched out (in different directions and at various distances) chains which were hooked to a good many trees and large bushes at once. The windlass was turned by two horses, and when they were set in motion the

ACCOUNT showing the RECEIPT from, and the EXPENDITURE incurred in, felling and disposing of the Timber upon the Crown Estate preparatory to the Land being Grubbed for Cultivation.

RECEIPT.			EXPENDITURE.		
	£.	s. d.		£.	s. d.
To amount received for oak and other timber	14,083	1 11½	By cost of felling, hewing, and preparing timber for sale ..	684	15 6
To amount received for bark	4,921	2 1	By cost of carting timber, and conveying to Woolwich the timber purchased by the War Department ..	2,491	17 6½
To amount received for cordwood, faggots, &c.	2,404	3 1½	By cost of stripping bark (including the felling of the trees from which it was taken)	1,777	10 9
To value of timber and materials supplied for fencing on the estate	397	0 2	By discount allowed to purchasers	25	17 4
To miscellaneous receipts	17	19 1	By cost of making cordwood, faggots, rails for fencing, &c.	1,736	11 1½
	21,823	6 5	By wages of woodmen, auctioneer's charges for selling produce, dinners to purchasers, advertisements, and receiver's poundage on receipts	1,025	9 10
To estimated value of timber left standing for shelter, &c. . .	2,450	0 0		7,742	2 1
			By balance	16,531	4 4
	24,273	6 5		24,273	6 5

tightest chain worked first, and when that had pulled down its tree, the chief strain fell upon another chain, and brought it into full play, and so on till all had done their work. It required three men to assist in this labour. After paying all the expenses attendant on felling and hewing the trees, stripping the bark, making the faggots, carting the timber according to agreement with the purchasers, and several other charges connected with this department, there remained a clear balance of 16,531*l.*, which is shown in the preceding table (page 275), where also each item of expenditure is clearly set out.

Grubbing the Land.—When the timber and brushwood had all been cleared away, much heavy work remained to be done; in many places a complete network of roots spread through the soil, and the hard, tough, stumps of trees that had been formerly felled, also remained in the ground. All these impediments caused serious hindrances to the men employed in grubbing; but stout tools, and the strong arms of Englishmen, are seldom overcome by difficulties. At a cost of 6233*l.* 10*s.*, or rather less than 3*l.* 10*s.* per acre (including superintendence), this part of the work was accomplished; some of the roots were carried away to serve as fuel for the cottagers near; but great quantities were burned on the land, rough firewood in the district having become so abundant, that it was not considered worth the expense of cartage. The following table gives the particulars:—

Cost of Grubbing 1903 Acres of Forest-land to render it fit for Cultivation.

	£.	s.	d.
Labour and materials, including the purchase of Fowler's machine, and of horses to work it }	5812	8	5
Surveyor's charges, and wages of Local Superintendent and Foreman }	491	4	1
	6303	12	6
Cr. Machine and horses sold }	70	2	6
Total expenditure in grubbing }	6233	10	0

Fencing.—The Commissioners had fenced the public roads with dry stone walls; the fences required to divide the land into farms were made with white-thorn quicks; first, lines were drawn in the required directions, and the ground was trenched about 3 feet wide, two rows of quicks (200 to a chain) were then planted on the level, and they were protected from injury by rough posts and rails on each side; the whole of this work, including materials, cost 28*s.* per chain. The contractor was bound by his agreement, to keep the young hedges clean, and the posts and rails in substantial order, for five years after com-

pletion; these young fences have grown vigorously, and where they have been carefully tended, promise to become in a few years, thoroughly efficient barriers.

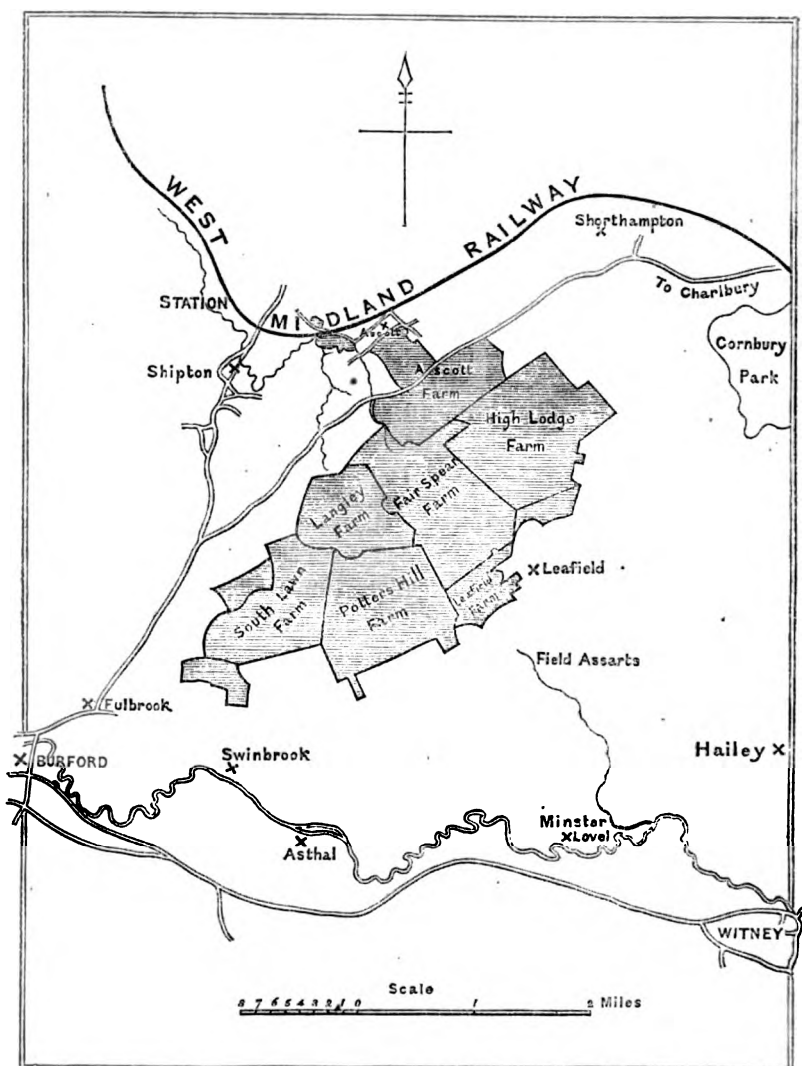
Farms.—The whole of the reclaimed land, together with some old cultivated fields which formed part of the Queen's allotment, and some land that was purchased, was divided into seven farms, as shown on the annexed map, which also points out the position of the estate south of the West Midland Railway, near to the ancient market-town of Burford, and about 5 miles north-west of Witney, a town long celebrated for the manufacture of blankets. The climate of this part of Oxfordshire is mild and healthy; the greater portion of this district in its geological character belongs to the oolite, and has proved suitable for sheep farming.

Farms let by Tender.—In 1858 the seven farms were advertised to be let by tender on leases of thirty-one years, from October 10, 1857. In the printed circular of information given to persons wishing to become the tenants, it was stated that buildings would be erected on the following conditions: 6 per cent. per annum to be paid by the tenants on all moneys expended in the erection of dwelling houses and farm buildings, and 5 per cent. on cash spent in the erection of labourers' cottages: the conditions respecting the course of cropping and other matters contained in a lease need not here be stated; suffice it to say, that the owner's rights were fully protected, and at the same time fair opportunity was afforded for enterprising tenants, to gather the fruits of any extra outlay they may feel inclined to make. The game was left entirely to the care and control of the tenants.

Tenders and Tenants.—As great publicity was given by the newspapers and other means, to the fact that the seven farms would be let on long leases, nearly two hundred persons, from different parts of England and Scotland, anxious to rent land, went to examine the Wichwood Estate; and as various as the visitors, were the opinions formed respecting the capability of the soil, and the probable results of its cultivation.

Nearly seventy tenders were sent in, and the following list shows the names of the new tenants, the acreage of each farm, and the quantity of forest land attached to each holding:—

M A P
OF AN
ESTATE BELONGING TO THE CROWN,
FORMERLY PART OF
WICHWOOD FOREST, OXFORDSHIRE.



Name of Farm.	Arable (Old Cultivated Land).			Pasture.			Homesteads.			Forest Land.			Total.		Tenants.
	A.	R.	F.	A.	R.	F.	A.	R.	F.	A.	R.	F.	A.	R.	
Ascott. . .	272	3	6	32	0	30	2	2	2	..	..	..	307	1	28
High Lodge. .	132	3	28	6	3	12	0	3	4	399	0	26	539	2	30
Fair Spear. .	156	1	39	27	0	30	2	1	39	444	0	29	630	1	26
Langley. . .	266	1	33	25	1	11	3	3	15	4	1	5	293	2	24
Potter's Hill. .	2	0	35	4	3	23	0	2	34	467	3	27	475	2	38
South Lawn. .	2	1	24	51	3	3	1	3	1	426	3	11	482	2	39
Leafield. . .	38	1	30	18	2	0	2	1	21	29	2	9	88	3	20
	990	2	35	166	2	37	14	0	36	1771	3	27	3343	2	15

The total expense incurred by the Crown in the reclamation and increase of the estate, and in furnishing it with suitable buildings, was as follows:—

General Account of Expenditure on the Crown Estate, Wichwood.

	£.	s.	d.
Purchases of additional land, and exchanges, surveyors' charges, &c., &c.	2615	15	2

Building Account—

The erection of two new farmhouses, with suitable offices, &c. One bailiff's house and offices. Six new cottages for labourers. Four new farm homesteads with stabling at each for fourteen horses, yards, cattle-sheds, barns, granaries, feeding-stalls, implement-houses, nag-stables, and all suitable offices. Also the erection of a water-wheel with tanks, pumps, &c., for the supply of water at five homesteads, and the enlargement of an old farmhouse	14,337	9	1
Grubbing 1903 acres of forest land to render it fit for cultivation	6233	10	0
Fencing, superintendence, and surveyor's charge	1303	7	10
Draining 78 acres 2 roods of old cultivated land	520	2	11
Construction of farm-roads, &c.	229	2	9
Superintendent's salary during the time all the works were in progress, allowance to tenants, repairs of roads, fences, &c., value of timber and stone supplied from the estate, and miscellaneous charges	1744	6	7
	26,983	14	4
Deduct the net sum received from the sale of timber, &c., on the estate, including the value of the timber left for shelter, &c.	16,531	4	4

Net outlay upon the estate 10,452 10 0

Present and Former Income from Wichwood Forest.—The present rental of the farms on the Wichwood Estate is 5104*l.* 7*s.* 6*d.* per annum; and the average net annual income from the Forest during the five years prior to the disafforestation was 1813*l.* 7*s.* 1*d.* The account will stand thus:—

					£.	s.	d.
Present annual return	..	..	..	..	5104	7	6
Former annual return	..	..	..	..	1813	7	1
Net annual improved income					3291	0	5

The above account of the improved income from Wichwood, as now under cultivation, must be highly satisfactory to us all as patriotic Englishmen and loyal subjects; and prove encouraging to enterprising agriculturists, and all owners of "Waste Land."

Effects of the Disafforestation of Wichwood.—Let us pause here awhile and consider what effects have sprung, and are likely to be produced, from the disafforestation of Wichwood. We have seen that the annual *cash* return from this property has been greatly increased; but however great may be the *pecuniary* benefit to the Crown, the effect on the *people of the neighbourhood and the community generally*, is of more consequence. Formerly, when deer and game abounded in the coverts, deer-stealers and poachers, idlers and thieves, were numerous around; conflicts between them and the keepers were frequent; imprisonment and transportation caused many families to lose their paternal head, and where matters did not reach this point, perhaps the abiding influences were still worse; a stolen buck could readily be disposed of; the amount paid for such plunder frequently amounted to 2*l.* or 3*l.*; but as ill-gotten booty is seldom well spent, the beer-shops too often absorbed the greater part of the proceeds; there was squandered in dissipation, what had been dishonestly obtained; a deserted home, a neglected wife, and children left to their own devices, filled up the background of this sad picture.* Fortunately the chief incentive to such vicious courses died out with the death of the last deer; honest employment can now be obtained on the new farms; each season brings its appointed work, and none need be idle who wish to be busy. Poets and painters may sigh because some fine woodland scenery has been swept away; but, of what consequence is a magnificent view, when compared with that plenty which has taken the place of poverty, or those habits of industry now firmly established, where dissipation and crime once abounded?

* The following is an extract from a small topographical description of the county of Oxford, published *many years ago*:—"An enclosure of Wichwood Forest would make a large tract of land productive to the public; the morals of the county demand it: this vicinity being filled with poachers, deer-stealers, thieves, and pilferers of every kind; the poor-rates too are higher in the parishes that surround the Forest than in others under similar circumstances, except that of being cut off from the Forest."

Visit to Wichwood by Members of the Land-Surveyors' Club.—

When the new farms had been occupied about nine months, the estate was inspected by a considerable number of the members of the Land-Surveyors' Club. Their Report, then published in the 'Times' and other newspapers, speaks in the highest terms of "the energy, talent, and judgment of the Crown Surveyor," adding that, "From the general and comprehensive arrangement down to the minutest detail, every part has been maturely considered and admirably executed, and with as much regard to economy, as consists with durability. The buildings are conveniently arranged and constructed without any other ornament than they derive from excellent proportion, and the sites are judiciously selected in reference both to the occupation of the land and the beauty of the prospects." . . . "For promptitude of execution and quality of work, this conversion of Wichwood Forest has hitherto been unequalled in this country; and whether it is regarded as an undertaking of interest or a lesson of instruction, it is equally worthy of inspection by the landowner or the professional surveyor."

Tenants' Work.—The land when given into the hands of the new tenants presented anything but a smooth, inviting appearance: wide ditches, and long, irregular high banks, that had formed the boundaries of the different coppices; deep pits and hollows, where stones had been dug for the use of bygone generations; small straggling briars that had escaped the notice of the woodgrubbers; roots of trees and underwood, left a few inches below the surface, by oversight or intentional neglect on the part of dishonest workmen; large patches of rough brown fern-stems, that had afforded covert to the fawns: all these and many other impediments stood in the way of the "forest farmers," and made "Speed the Plough" an earnest desire with the ploughmen but seldom realised; for it was with the greatest difficulty that four strong horses drawing a large iron plough could break up half an acre a-day; and many and long were the blacksmith's bills for repairs to the "tackle" where the plough was used in breaking up the soil. Some of the tenants tried digging, at a cost of 3*l.* per acre; some used stocking-hoes, and *grubbed* the ground 5 inches deep, carefully picking out the large stones that were beneath the surface; this plan cost 50*s.* per acre. On Potter's Hill farm, breast-ploughing and burning was adopted; and this course appeared to answer better than any of the others.

Potter's Hill Farm.—"The novel, skilful, and economical system" adopted on this farm formed the subject of special remark and commendation in the Report drawn up when the members of the Land Surveyors' Club visited Wichwood.

This farm comprises 475 acres, the whole of which, with the

exception of 8 acres, was rough forest land. According to the terms of the agreement, 10 acres were to remain as copsewood, and about 14 acres to be kept in pasture; therefore there remained in round numbers 450 acres to be used as arable land by the tenant. The whole of this land would have been cropped the first season had not some of the hewn timber been placed on certain portions of the farm, and an agreement entered into with persons who purchased wood for the manufacture of charcoal, that they should be allowed space and turf for their fires, and roadways to draw off the produce during the summer months of 1858.

In the spring of 1858, 320 acres were planted with oats; and in the summer of the same year 99 acres were sown with swedes and turnips. The cultivation for these crops was done by *hand-labour*: the men worked in gangs of eight, ten, or sixteen together.

For the oat-crop the ground was breast-ploughed about $1\frac{1}{2}$ inches deep; and as soon as it was sufficiently dry it was dragged and harrowed by horses. More harrowing was required in the roughest places than in other parts where less brushwood had grown. Every opportunity was taken when the weather was dry to rake together and burn the pieces of turf and rubbish that the ploughs had pared off, and the harrows scratched out: by this plan immense quantities of ashes were made; some of them were carted to large heaps for future use, and the remainder spread evenly on the surface; the oats were then sown broadcast (about 4 bushels per acre), then the breast-ploughs with another furrow buried the seed-corn and ashes together on the firm ground; an ordinary roller followed; and after that a bush-harrow was drawn over the surface to fill the seams left by the breast-ploughs. I should mention that men had previously been engaged in grubbing up small roots and rough places that were likely to impede the work.

The ground allotted for the turnip-crop was treated in the same manner as the oat-land, except that it had more harrowing, dragging, and rolling to get it into fine tilth, and was breast-ploughed a third time; after receiving a dressing of artificial manure, composed of two-thirds superphosphate, and one-third Peruvian guano, the turnip-seeds were sown broadcast after the third ploughing, and merely bush-harrowed once; the surface was then made firm with an iron roller.

On this farm there were nearly six miles of the high banks and deep ditches, the boundaries of the old coppices. These were all lowered; but it was not thought advisable to level them entirely in the first year. Since then they have been still further reduced by ploughing deep furrows inwards; or where the banks

were too steep for this work they have been thrown down by picks and shovels.

As to the produce of the first corn-crops, it may be sufficient to state that they were at least equal to an average of the returns from the old cultivated lands of the district. The first crop of swedes and turnips was undoubtedly far superior to the general crops of the locality. Up to the present season (1863) this farm has been cultivated by the breast-ploughs instead of horse-ploughs, and the crops have been satisfactory to the occupier. Whether this plan will be continued, or a steam cultivator or horse-ploughs used, is a matter for future consideration.

The following Tables show the prices paid for the different works performed both by owner and occupier :—

Owner's Work.

Road-making, including digging stones and cartage	3l. 0s. to 4l. 8s. per chain.
Building boundary-walls, 4 ft. 3 in. high, including digging stones and cartage ..	1l. 4s. „ 1l. 6s. „
Draining 4 ft. deep, including the pipes and superintendence	5l. 0s. „ 6l. 0s. per acre.
Clearing the land of timber and grubbing the same, including superintendence ..	2l. 10s. „ 3l. 10s. „
Fencing with thorn quicks, including trenching the ground, supplying posts and rails, and keeping all in order for five years	1l. 8s. per chain.

Price List of Tenant's Work, Potter's Hill Farm.

Breast-ploughing and burning, and spreading the ashes first time	1l. 2s. to 1l. 4s. per acre.
Breast-ploughing the oats in, or breast-ploughing the second time for turnips ..	18s. „
Breast-ploughing the third time for turnips ..	8s., 10s., to 12s. „
Grubbing stray roots, &c., before breast-ploughing the first time	5s. to 6s. „
Throwing down old banks, and filling old ditches	1s. to 3s. per chain, according to the work required.

All the other labour performed on this farm during the first year was of the ordinary kind, and was executed at the usual price of the district. The following is a brief sketch of the plan proposed for cropping this land during the next few years; but should sainfoin, and some other plants that have not yet been tried, be found suitable to the soil, then a change in the rotation will be adopted.

Proposed Course of Cropping for Potter's Hill Farm.—After laying down to permanent pasture 25 acres, and deducting 10 acres for homesteads, rickyards, garden ground, and copse-wood, &c., there will remain as arable land, in round numbers, 450 acres; and allowing 10 acres each year for the growth of

carrots, cabbages, lucerne, and other green food for horses, pigs, &c., in yards, there will remain five portions, each of 88 acres. If we follow one of these plots through the course of five years, we shall see the rotation, as at present proposed, for the whole farm.

1st year, 88 acres	{ Swedes, turnips, mangolds, and other green crops manured with yard dung, artificial manure, or both.
2nd „ 88 „	{ Barley; with this crop clover-seeds to be sown, or on a portion clover may be omitted.
3rd „ 88 „	{ Clover or beans, with dung.
4th „ 88 „	{ Wheat dunged before or after planting.
5th „ 88 „	{ 22 acres late sown white swedes or mangolds, dunged or dressed with artificial manure.
	{ 33 „ beans and peas.
	{ 33 „ oats to be dressed with guano.
	—
	88 „

By the above plan it will be seen that every year one-fourth of the land will be planted with swedes and turnips; and the 22 acres of *late-sown* white swedes or mangolds, in No. 5, will be in turnip-crop the following year. All the barley-land may be sown in good season, although the sheep may be eating swedes and mangolds *long* after it is desirable to finish barley sowing. By the foregoing plan the clover will be grown on the same land not more often than once in five years; and it is hoped that the failure of the clover-crop will thus be avoided. Circumstances may probably arise to cause an alteration in the proposed cropping; for, as the late lamented Philip Pusey, Esq., justly remarked, that “in rural affairs what was sometimes a good practice on the hills was a bad one in the valleys;” so may we say that a course of cropping that is considered good in the year 1863 may be found in the year 1873 lagging far behind the best of that distant day.

General Remarks on Waste Land.—No one who has been for any length of time an observer of rural affairs can fail to remember that often at the corners of the streets of our little market-towns, and on our village-greens, he has seen groups of hardy, sturdy men, able and willing to work, and yet “standing all the day idle,” because “no man had hired them”? And can he not also remember that at the same moment, within an easy distance of these unemployed people, there was land then lying waste, and producing barely enough to sustain a few miserable half-starved cattle or sheep—land now cultivated, which then as well as now would have given honest employment, and borne then as well as now glorious crops of grain? The days are happily

at an end when such unemployed labourers became the easy dupes of ignorant and designing men, and were urged to acts of violence and guilt,—the riotous breaking of farm-machinery by day and incendiary fires by night; but have they left behind the lesson which they should convey, or do we need the repetition of these evils to impress on the minds of the rising generation the truth of the homely English proverb, “Wilful waste makes woeful want?” It surely cannot be argued that all the waste land of England has been enclosed, and nearly all has been brought into cultivation that is worth the trouble and cost of ploughing. We grant that many thousands of acres have within the last twenty years been reclaimed; and hardly a year passes in which important acts of enclosure are not effected. Still much remains to be done nearly everywhere in the way of reclamation; and it would be for the profit both of owner and occupier of English soil to look more closely into this; and though there may not be under the control of many, heaths and downs on a large scale, giving no more produce than they did eight hundred years ago, are there not “wastes” on most of our cultivated farms? pieces that appear insignificant when looked at separately, but are of great consequence when considered collectively? There are the wide-spreading hedgerows, causing waste; there is the sluggish inland stream, which, by its tortuous course and its half-choked channel, causes waste on the right hand and on the left; there is waste by the river side and by the sea-shore; by the mountain slope and in the sheltered valley; there is decaying timber, which, by its roots and shade, causes waste; there is much grass-land little better than waste. Although we would not wish to see the plough working close to the windows of the noble mansions that are scattered over our country, still we say, the “reclamation of wastes” is a subject well worth the consideration of all connected with landed property. Such works suggested and influenced by the first supreme command to man, “Replenish the earth and subdue it,” would produce good effects; give healthy exercise to the mind; afford honest employment to the horny hands of those who toil early and late for their daily bread; afford the means of adding to the supply of food of our rapidly increasing population; it would further the coming of that happy time when “the wilderness shall be a fruitful field,” and the fruitful field as a garden.

Little Coxwell, Faringdon, Berks.

XIX.—*On Milk.* By DR. AUGUSTUS VOELCKER.

MILK is a secretion produced from the elements of blood and chyle by the mammary gland of the female animal of the order Mammalia, after giving birth to young. It is a whitish opaque liquid, of an agreeable sweetish taste, and faint but peculiar odour. It is slightly denser than water. Cow's milk of good quality has a specific gravity of about 1030; woman's milk, 1020; goat's and ewe's milk, 1035 to 1042; ass's milk, 1019; that of water being 1000.

Cow's milk and the milk of other herbivorous animals is either neutral, or more generally, when quite fresh, slightly alkaline; the milk of carnivorous animals has always an acid reaction, when tested with blue litmus paper.

Viewed under the microscope, milk appears as a transparent fluid, in which float innumerable small round or egg-shaped globules, the so-called milk-globules. The fluid constitutes the bulk, and the milk-globules but a small fraction, of the milk.

Completely separated from the milk-globules, the fluid is a perfect solution of the following substances:—

1. Curd, or casein.
2. Albumen.
3. Milk sugar.
4. Mineral matters.

The milk-globules consist of:—

5. Thin shells of curd, or casein, enveloping
6. Fatty matters (the fats of butter).

Composition and Properties of Curd, or Casein.—When milk is allowed to turn acid by keeping for some days, or when any acid or rennet is added to new milk, the curd of milk, contaminated with more or less butter, separates in the form of a white, flaky voluminous substance, having a slightly acid reaction.

Dried on a water-table, it shrinks greatly in bulk, and becomes semi-transparent and horn-like. In this condition it is scarcely soluble in water, but dissolves with readiness in a weak solution of caustic potash and soda, and is again re-precipitated from its alkaline solution by acetic or mineral acids, and restored to its former gelatinous condition.

Casein exists in milk in a state of solution, and is distinguished from albumen, which it resembles closely in composition and general physical properties, by not coagulating on boiling, and by being precipitated by rennet.

On boiling a solution of casein, it absorbs oxygen, and in consequence a pellicle, which is insoluble in water, is gradually formed upon the surface. A similar pellicle is formed when

skimmed milk is boiled. New milk gradually heated to nearly the boiling point of water throws up cream, whilst at the same time a skin of oxydized casein is formed on the surface. Thus in "Devonshire" or "clotted cream" we find more curd than in cream collected in the ordinary manner.

The solubility of casein in milk is generally ascribed to the presence of a certain small proportion of free alkali. But though it is quite true that alkalies are excellent solvents for casein, and milk is frequently slightly alkaline, it may be questioned whether the solubility of casein is due to the presence of free alkali; for even in milk which is slightly acid, and therefore does not contain any free alkali, all the curd occurs in a soluble form, nor does the addition to new milk of dilute acid in quantities which, though small, are sufficient in quantity to render it decidedly sour, cause the separation of casein. This takes place only after a large quantity of lactic acid has been formed spontaneously, or an excess of free acid has been put into the milk.

The action of rennet on the soluble form in which casein occurs in milk is peculiar, and as yet unexplained. It was supposed for a long time that the rennet coagulated milk by converting the sugar of milk into lactic acid, and that the lactic acid, by neutralizing the free alkali, was in reality the agent in effecting the separation of the curd in a coagulated condition.

But this view is no longer tenable, for rennet at once coagulates new milk without turning it acid in the slightest degree. I have even purposely made milk alkaline, and yet separated the curd by rennet, and obtained a whey which had an alkaline reaction. (For detailed experimental evidence on this peculiar action of rennet on soluble casein the reader is referred to my paper on the Composition of Cheese, in vol. xxii., part i., of this Journal.)

Curd exposed to air in a moist condition undergoes partial decomposition, and becomes a ferment, which rapidly decomposes a portion of the neutral fats of butter, separating from them butyric and other volatile fatty acids, which impart the bad flavour to rancid butter. Casein-ferment also rapidly converts milk-sugar into lactic acid.

Like all albuminous substances, casein contains a large proportion of nitrogen, and is capable of producing flesh in the animal economy.

Mulder does not mention phosphorus as a normal constituent of casein. I find, however, in it a considerable quantity of phosphorus, and rather more sulphur than is given in Mulder's analysis. The following results were obtained by me on submitting pure casein to an ultimate or elementary analysis:—

<i>Composition of Casein.</i>							
Carbon	..	..	..	..	..	..	53.57
Hydrogen	..	..	..	..	..	..	7.14
Nitrogen	..	..	..	..	..	..	15.41
Oxygen	..	..	..	..	..	..	22.03
Sulphur	..	..	..	..	..	..	1.11
Phosphorus	..	..	..	..	..	..	.74
							100.00

Pure casein of milk has almost precisely the same composition as vegetable casein, or legumin, and possesses the same physical and chemical properties.

Vegetable casein, I may observe in passing, is far more abundant in plants than albumen. Since fibrin or muscular fibre, which contains phosphorus, can as readily be produced from casein or legumin, as from albumen in which phosphorus is a recognised constituent, it may be reasonably expected that casein and legumin should also contain this element.

I find, indeed, that all the members of the group of albuminous or flesh-forming matters contain phosphorus, as well as sulphur; which indicates that there is nothing wanting in the composition of any of them which might render any one less useful than another as a flesh-producing material. It is difficult to obtain casein entirely free from mineral matters. Phosphate of lime especially clings to casein with great pertinacity,—a circumstance which has prevented scientific chemists from recognizing the existence of organic phosphorus in casein. By organic phosphorus we mean phosphorus chemically united with carbon, nitrogen, and the other ultimate organic constituents of casein.

In this intimate organic combination the usual properties of phosphorus remain entirely concealed, and the most delicate tests fail to trace its existence unless the casein be completely decomposed by chemical means, or until it has been subjected to putrefaction. When the latter sets in, phosphoretted hydrogen appears amongst the gaseous products formed.

In the preceding analysis the ash, amounting to only .317 per cent., has been deducted previous to calculating the composition in 100 parts. About one-third of the ash, or in exact numbers .11 per cent., was phosphate of lime. It will be seen that the amount of phosphorus which I discovered in casein is greater than the total amount of ash, showing clearly that phosphorus occurs in casein in combination with the organic elements, carbon, hydrogen, nitrogen, and oxygen, and not exclusively in an oxydized state as phosphoric acid. It is true, phosphate of lime cannot be completely removed from casein, but by careful purification its amount may be reduced to a minimum. Moreover,

the amount of phosphates can be determined separately by a plan which I communicated some years ago to the British Association for the Advancement of Science.

2. *Albumen*.—Rennet separates milk into curd and whey. When the operation has been properly conducted, a perfectly clear whey is obtained. On heating the clear and filtered whey nearly to the boiling point of water, a flaky, curd-like substance separates itself. This substance is considered to be albumen. It exhibits all the distinguishing properties of the white of eggs, or albumen, but has not as yet been subjected to ultimate analysis.

The albumen, or albuminous matter, which is not separated by rennet, but coagulates on boiling the whey from which the curd has previously been removed, amounts in cow's milk to from $\frac{1}{2}$ to $\frac{3}{4}$ per cent., or about $\frac{1}{4}$ or $\frac{1}{3}$ part of the casein.

It is somewhat remarkable that this albuminous matter does not coagulate when new milk is simply raised to the boiling point of water. In this case a pellicle of oxydized casein is formed on the surface, but no albumen separates, and it thus appears that the curd of milk has first to be removed by rennet before the albuminous matter can be obtained in a coagulated form.

3. *Sugar of Milk*.—This variety of sugar is solely obtained from the milk of mammalia. It is abundant in the milk of the herbivora, and only sparingly secreted by the carnivora.

Milk-sugar is contained in the clear whey from which curd and albumen have been removed by rennet and boiling, and is prepared in the following simple manner:—The clear whey is evaporated in shallow vessels until crystals begin to separate, then poured into the crystallizing pans, in which small pieces of wood are introduced, or strings are suspended, to act as nuclei for the deposit of the crystals of sugar of milk. In this way it is obtained in long round sticks of a thickness of 2 or $2\frac{1}{2}$ inches in diameter, presenting groups of right four-sided prisms, terminated by four-sided pyramids. The whey from which these crystallized masses have been removed, on further evaporation furnishes a second, less pure, smaller, yellow-coloured crop of crystals. The purer variety is largely produced in Switzerland, where it forms an important article of commerce.

Sugar of milk, or lactose, is less sweet to the taste than grape or cane sugar. It requires 5 to 6 parts of cold water for solution, dissolves readily in boiling water, and crystallizes again, on cooling, in white, semi-transparent, hard, small crystals, which feel gritty between the teeth. It is insoluble in alcohol and ether.

In a pure state it may be kept unaltered for any length of time, being then insusceptible of fermentation. But if left in contact with casein and air, it gradually becomes changed either

into lactic acid or into fruit-sugar, which in its turn enters into alcoholic fermentation, producing carbonic acid and alcohol.

Under favourable circumstances milk may thus be fermented, and converted into an intoxicating alcoholic beverage. It has, however, under the influence of partially decomposed casein, which acts as a ferment, a greater tendency to turn acid than to enter into alcoholic fermentation, especially when the temperature of the air is high.

Sugar of milk, or lactose, contains, when pure, in 100 parts—

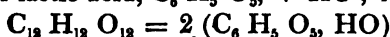
Carbon	..	..	..	..	..	..	..	40.00
Hydrogen	..	..	..	..	..	..	..	6.66
Oxygen	..	..	..	..	..	..	..	53.34
								100.00

These numbers correspond to the formula $C_{12}H_{12}O_{12}$ which is assigned to it by chemists. It will be seen that it is free from nitrogen, and contains hydrogen and oxygen in the same relative proportion in which these two elements occur in water.

Sugar of milk may therefore be represented to be a carbonhydrate, or compound of carbon with water only.

Lactic acid and fruit-sugar, though widely differing in their physical and chemical properties, nevertheless contain in 100 parts precisely the same amount of carbon, hydrogen, and oxygen as sugar of milk.

Under the influence of casein-ferment lactose is changed into lactic acid in the simplest possible way. Without gaining or losing anything, 1 equivalent of lactose, $C_{12}H_{12}O_{12}$, splits into 2 equivalents of lactic acid, $C_6H_5O_5$, + HO; for



1 equivalent of lactose = 2 equivalents of lactic acid.

4. *Mineral Matters* (Ash of Milk).—When milk is boiled down, and the dry matter burnt, it leaves from $\frac{1}{2}$ to $\frac{3}{4}$ per cent. of a whitish ash, which consists mainly of phosphate of lime and magnesia (bone earth), and the chlorides of potassium and sodium, besides a small quantity of phosphate of iron and some free soda.

The relative proportions of these several substances yielded by 1000 lbs. of the milk of two different cows, as given by Haidlen, are as follows:—

	lbs.	lbs.
Phosphate of lime	2.31	3.44
Phosphate of magnesia	.42	.64
Phosphate of peroxide of iron	.07	.07
Chloride of potassium	1.44	1.83
Chloride of sodium	.24	.34
Free soda	.42	.45
	1.90	6.77

5. *Milk Globules*.—The milk globules are small round or egg-shaped bodies, which enclose in a thin shell of casein a mixture of several fatty matters. They are somewhat lighter than milk, and consequently rise on the surface when milk is set aside in skimming-dishes.

In the degree in which the milk globules are thrown up and removed in the shape of cream, milk gets less opaque, and assumes a more decidedly blue colour.

By churning cream the casein shells are broken, and the contents of the milk-globules made into butter.

Butter consists mainly of a mixture of several fats, amongst which palmitin, a solid crystallizable substance, is the most important.

Palmitin, with a little stearine, constitutes about 68 per cent. of pure butter. Mixed with these solid fats are about 30 per cent. of olein, a liquid fatty matter, and about 2 per cent. of odoriferous oils. The peculiar flavour and odour of butter are owing to the presence of this small proportion of these peculiar oils, viz., butyric, caproic, and caprylic.

In butter, as it comes on our table, we find besides these fatty matters about 16 to 18 per cent. of water; 1 to 2 per cent. of salt; and variable small quantities of fragments of casein shells. The more perfectly the latter are removed by kneading under water, the better butter keeps; for casein on exposure to air in a moist state, especially in warm weather, becomes rapidly changed into a ferment, which, acting on the last-named volatile fatty matters of butter, resolves them into glycerine and butyric acid, $C_4H_8O_4$; caproic acid, $C_{12}H_{24}O_4$; and caprylic acid, $C_{16}H_{32}O_4$.

The occurrence of these volatile, uncombined fatty acids in rancid butter not only spoils the flavour, but renders it more or less unwholesome.

On Dairy Arrangements.

Having described the principal properties, and given the composition of all the chief constituents of milk, we offer a few observations on dairy arrangements, more especially on the means for keeping milk and cream in the best condition. It is hardly necessary to remind the reader that too much attention cannot be bestowed upon keeping the dairy itself, as well as the milk-pails, pans, and other dairy utensils, scrupulously clean. But as some people have an impression that cleanliness can only be maintained in the dairy when almost unlimited quantities of water are used for washing the floor and cleaning the various utensils, a few words of caution against the injudicious and wasteful employment of water, may not be out of place. Of course there

must be close to the dairy a good supply of clean water ; but the less water is used for washing the floor and benches the better, for nothing is more injurious to milk than a damp floor and close, moist atmosphere. That which is used ought to be scalding hot, and the evaporation should be further accelerated by a rapid current of air. Proper means of ventilation, therefore, should exist in every well-constructed dairy. The milk-pails, pans, straining-cloths, and all other utensils when used should be washed immediately with scalding water, and not set aside uncleaned until they are again wanted. The dairy-maid should not show her zeal for keeping the dairy clean by splashing water about. Above all she should prevent men or women from entering her domain with dirty shoes, or in any other way bringing dirt into the dairy. In wet weather the introduction of dirt may not be altogether avoidable, but it may be reduced to a minimum by having a good scraper and rough door-mat at the entrance, as well as a pair of wooden shoes for each man who brings in the milk, which may be readily slipped on and off on entering and leaving the dairy. Any one who doubts the efficacy of these simple means should visit North Brabant, which is justly celebrated for its excellent butter. Dairies which are models of cleanliness can there be seen, not here and there, but almost universally throughout the district. The best aspect for the dairy is one facing the north ; but after all this is not essential, so long as the room is dry, well ventilated, and protected by blinds or shutters from the direct rays of the sun.

The great defect in many of the dairies in England is the want of proper ventilation. This is a fertile source of dampness, which is specially detrimental to the preservation of milk. One of the most effectual and inexpensive means of providing a renewal of air is to put up a perforated zinc grating, 3 or 4 inches broad, which may be run all along the top of the windows. In addition to this a whole window, made to open and shut, may be furnished with perforated galvanised sheet zinc. The walls of the building should be thick, and, if of stone, lined inside with brick. If a separate building, the roof of the dairy should not be covered with black slates, which, being good conductors of heat, get very hot in summer. A better material for covering the roof is Stonesfield slates, or similar limestone flag-stones ; or, if these cannot be procured, common red tiles should be used in preference to black roofing-slates. But the best cover is unquestionably a straw roof ; for straw being a very bad conductor of heat, preserves a more uniform temperature in the dairy than any other kind of roofing material.

The floor should be of stone ; large flag-stones, well set in

cement, appear to us preferable to ornamental or common small tiles. Tiles being small when laid down leave a much larger number of joints in which water may lodge, than large-sized flag-stones: such a floor is therefore less dry.

Benches covered with slate or marble are superior to wooden benches. But if the latter are in use on account of their greater cheapness, they should be painted, in order that any milk which may be accidentally spilled can be readily removed, and not penetrate the wood. Milk spilled on porous wood penetrates it, and cannot be removed by cold water. Even with hot water it is not easy to remove every trace, and that which remains will soon be converted into an active ferment.

In warm weather everybody knows milk is more apt to turn sour than in cold. To secure greater coolness many have been induced to build the dairy at a lower level than the ground around. Underground dairies, however, are frequently damp; so that on a clay soil it is better to choose the lesser evil, and to build on a level with the ground. In such localities it is well to put a drain all round the dairy.

Our great aim in constructing dairies should be to erect a dry and well ventilated building in which a uniform temperature is readily maintained all the year round.

In winter it will be necessary to heat the room, and this should be done by hot-water pipes; since with a stove or open fire it is next to impossible to maintain an equal temperature. Too low a temperature in a dairy is unfavourable to the rapid separation of the cream. Experience has shown that a temperature not lower than 60° , and not higher than 65° , is most conducive to the rising of the cream-globules; and the more uniformly the temperature can be kept at about 60° Fahr. throughout winter and summer, the more readily the cream will be thrown up; whilst the milk will be kept sweet, provided the dairy is dry and properly ventilated. On no account should the temperature be allowed to fall below 55° . An accurate thermometer ought for this reason to be hung up in every dairy.

Those milk-pails which are made of bright tin are decidedly better than wooden ones. Unless great pains are bestowed on scouring the latter with boiling water they taint the milk; indeed, it is always difficult to preserve them from all smell, whilst tin pails can easily be kept sweet and bright.

Before the milk is put up into pans it should be run through a straining cloth. A good contrivance for straining milk has been devised by Major Gussander. The accompanying sketch represents a vessel made of tinned iron, with a strainer attached to it:—

Before putting the spout-like strainer (*b b*) on the bent neck of the vessel, a piece of coarse calico is put at (*a*), over the mouth of the neck of the bottle.

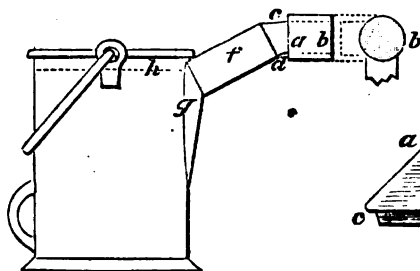


Fig. 1.



Fig. 2.

Fig. 2 represents the lid fitting the tin vessel into which the milk is strained. The lid has a round aperture at (*a b*). Instead of ordinary round earthenware or glass milk-pans, Major Gussander uses very shallow, oblong, large pans made of tinned iron.

The following figure (3) represents a milk-pan shown by Major Gussander at the London International Exhibition of 1862:—

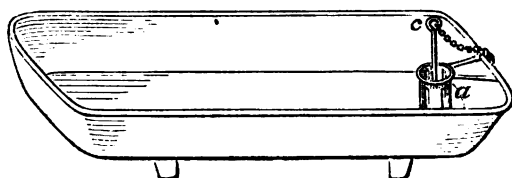


Fig. 3.

This pan is only $2\frac{1}{2}$ inches high; the sides bent in an outward direction, at an angle of 40° ; the corners are carefully rounded off, to facilitate the cleaning. They are made of tinned iron, and large enough to hold about 2 gallons. In the bottom of the pan there is a small opening, closed by a brass plug (*c*), when the milk is set for cream. A small cylindrical tube (*a*) is soldered over the opening, through which the skimmed milk passes when the plug (*c*) is pulled out. The cylindrical tube is provided with several narrow slits, through which the milk can readily flow off, but which afford no passage to the thick cream.

Fig. 4 is a vertical section of the cylindrical tube and brass plug; and Fig. 5 a horizontal section of the same

The milkers pour the contents of their pails into the tin vessel (fig. 1), which may be placed close to the door, so that the men need not enter the dairy at all. From this vessel it is poured into the shallow tin pans to a depth of $1\frac{1}{2}$ to 2 inches, and left at rest for 24 hours, after which time the milk is drawn from under the cream by pulling out the brass plug, &c.

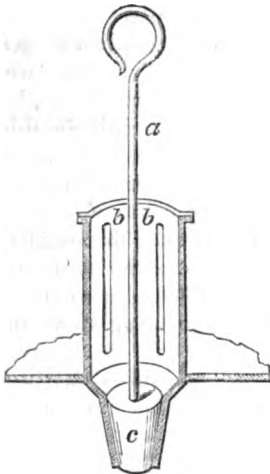


Fig. 4.

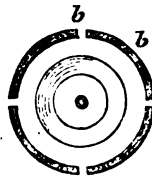


Fig. 5.

Pans of that shape and depth are well adapted for keeping the milk perfectly sweet, even in summer, for at least 30 hours, and to throw up within 24 hours nearly all the cream that can be separated at all. The cream thus obtained, being quite sweet, unquestionably produces a finer-flavoured butter than that which is made of sour cream, as is commonly the case.

The chief peculiarity of these pans is their shallowness. Major Gussander's pans are only 2 inches deep, and they are filled with milk to a depth of $1\frac{1}{2}$ inches. I am inclined to think they might be made $2\frac{1}{2}$ inches deep, and of such dimensions as to hold 4 or 5 gallons of milk, and be put up in dairies as fixtures, resting on stone slabs or slate. They do not require to be scrubbed, and keep perfectly bright if they are washed out with a clean sponge, kept for this purpose and a little boiling water, directly the contents have been removed. The sponge should be rinsed out, put for a minute or two in boiling water, and then hung up to dry in an airy place.

Glass pans are easily kept clean, and are otherwise well adapted for keeping milk and cream in a sweet condition. Like all round

pans, they take up more room than square or oblong vessels. They are, of course, very brittle, and liable to be broken, and on this account more expensive in the long run than cisterns made of lead or tinned iron. Glazed earthenware pans, 20 to 22 inches across at top, and $3\frac{1}{2}$ to 4 inches deep, and 1 foot to 14 inches wide at bottom, are very commonly used in England. They should be well glazed, in order that the milk may not penetrate the porous earthenware. Unglazed pans or wooden dishes are decidedly objectionable. Porous materials are generally objectionable for dairy use. Vessels cut out of stone are more porous and more difficult to keep clean and sweet than glass pans or tin vessels; and many limestones are quite unfit for this purpose. A better material is slate, provided the vessel is cut out of the solid block. If it be made by joining together several slabs of slate, it will prove, perhaps, the worst description of milk-vessel that has ever been constructed. The difficulty of thoroughly removing all traces of the old milk which penetrates the joints of the slabs, or is absorbed by the cement with which the slabs are joined together, accounts for the milk not keeping sweet in them. Zinc pans are said to throw up more cream than pans made of any other material. Zinc, however, is readily oxydised, and in an oxydised state easily attacked by milk. As the zinc salts thus formed are decidedly injurious to health, and, moreover, zinc pans are difficult to keep untarnished, this material ought not to be used for milk-pans. Brass and tinned-copper pans, when kept exceedingly clean, are unobjectionable; but as they are too expensive, and in the hands of careless dairy-maids may poison the milk, it is on the whole better not to employ them.

Probably the greatest quantity of milk in this country is set for cream in leaden cisterns about 4 or 5 inches deep; yet tinned-iron cisterns are on the whole preferable, as being more easily kept clean. It is a great mistake to put up the milk in cisterns 4 or 5 inches deep. Such deep vessels economise space, and cost less than a number of small pans requiring to be renewed from time to time; but what is gained on the one hand is lost on the other, by the smaller quantity and the inferior quality of the cream which they give, in comparison with shallow vessels.

The quicker cream can be made to rise the better its quality; for cream, like all perishable substances, does not preserve its original properties for any great length of time. The cream, or rather milk-globules, being lighter than the fluid portion of milk, necessarily rise in a shorter time from a less depth than from a greater depth, because they have less pressure to overcome than those in the deeper strata; the action is also more complete, as

well as more rapid, in shallow vessels. There is another reason for preferring shallow vessels. Milk as it comes from the cow has a temperature of about 90° . If kept in this condition for any length of time, air being freely admitted, it rapidly turns sour. Hence it is of consequence to reduce it as rapidly as possible down to a temperature of at least 60° Fahr. In a shallow tinned-iron milkpan placed upon stone this change is soon effected; and then, in a good dairy, the milk may be kept from 36 to 48 hours, at a season when in deeper vessels it would soon turn sour. When once begun, the process of acidification cannot be stopped by any available means. Hence it is of great importance to cool down the milk as rapidly as possible. As metals are good conductors of heat, shallow tinned-iron milk-vessels, resting on stone, are better adapted to keep milk sweet than glass or earthenware, or slate-pans, placed on a bad conductor like a wooden bench.

It must not be imagined, however, that the lower the temperature is allowed to sink the more cream will rise; for we must bear in mind that with the reduction of the temperature the specific gravity of the liquid is raised, and the rising of the cream or milk-globules checked accordingly.

When shallow metallic milk-vessels are employed in a proper dairy, kept at this temperature, all the cream that will rise at all will have come to the surface in about 24 hours. Under these circumstances it is therefore no use to set milk aside for a longer period. Some people let milk get sour before they skim it; but although the layer of cream in that case appears more bulky and of greater consistency, it does not produce so much nor so good a quality of butter. On this point we possess an interesting experiment by Sannert, who put aside two equal quantities of milk, of which the first skimmed after 30 hours yielded 30 lbs. of butter; and the second skimmed after a lapse of 60 hours, only 27 lbs. of butter.

In another experiment two equal quantities of milk yielded—the one when skimmed after 30 hours, 31 lbs. of butter; and the other after 60 hours, 29 lbs. of butter. In both experiments, in which the milk was skimmed after 30 hours' standing, the skimmed milk was still sweet, and the cream not so thick and less in bulk than that which was thrown up after 60 hours' standing.

Composition of Cream.—As may be expected, the composition of cream varies greatly, according to the circumstances under which it is produced. Four different samples analysed in my laboratory yielded the following results:—

	I.	II.	III.	IV.
Water	74.46	64.80	56.50	61.67
Butter (pure fatty matters) ..	18.18	25.40	31.57	33.43
*Casein	2.69	{7.61}	{8.44}	2.62
Milk-sugar	4.08			1.56
Mineral matters (ash)	0.59	2.19	3.49	0.72
	100.00	100.00	100.00	100.00
* Containing nitrogen ..	.43	.. ..	.. ..	.42

Cream is lighter than milk, but slightly denser than pure water; consequently it sinks in distilled water. No. 1 was skimmed off after standing for 15 hours, and was found to have a specific gravity of 1.0194 at 62° Fahr. The specific gravity of two other samples of cream which stood 48 hours was 1.0127 at 62° Fahr., and 1.0129 at 62° Fahr. Rich cream, I find, has a lower specific gravity than thin cream mixed with a good deal of milk, such as the sample analysed under No. 1.

No. 2 may be taken as representing the composition of cream of average richness. It then contains about one-fourth its weight of pure butter.

These differences in the composition of cream fully explain the variable quantities of butter which are produced by a given bulk of cream.

On an average, 1 quart of good cream yields from 13 to 15 ounces of commercial butter. Occasionally cream is very rich in fatty matters, and then yields much more butter. Thus Mr. Horsfall states that a quart of cream in his dairy yielded 1 lb. of butter, when the cows were out in grass, and no less than 22 to 24 ounces of butter when the cows were fed in the house on rape-cake, bran, and other substances rich in oil.

The cream which rises first I find is always richer in butter than that which is thrown up later. Such differences are always particularly marked in warm weather. Generally speaking, cream yields more butter when its bulk, in proportion to that of the milk from which it is taken, is small, and *vice versa*. Thus, in Mr. Horsfall's dairy, the cream did not exceed 6½ per cent. in the bulk of the milk; but it was so rich as to yield 25 ounces of butter per quart.

In an experiment which I published last year only 4 per cent. of cream was thrown up by the milk. This cream, however, was so rich that 10 quarts yielded 18 lbs. of butter.

The first portions of cream which rise are always thin, but rich in fat; a fact which is explained by the circumstance that during milking and the subsequent agitation to which milk is exposed, a portion of the milk-globules get broken, in conse-

quence of which their light fatty contents, liberated from the denser casein-shells, rise to the surface with greater facility, and there occupy less room than the unbroken milk-globules, which, on account of their greater specific gravity, are more sluggish in rising.

In my experiments the milk had to be measured out several times over, in order to secure accuracy; and this exposure to extra agitation explains the unusually small bulk of the cream: since in all instances of careful experiment the milk must be a good deal agitated, until it becomes a sort of mixture of ordinary cream and ready-made butter. The large quantity of butter yielded by cream in Mr. Horsfall's and my own experiments is explained by this circumstance. We may learn from this that on farms where cream is sold the milk should not be shaken more than is absolutely necessary.

Although no doubt originally all the butter exists in the shape of butter-globules, a partial separation, however, between the contents and the envelopes of these take place already in the udder of the cow; for if ether, an excellent solvent for unencased fatty matter, is carefully mixed with the milk as it comes from the cow, and the layer of ether which collects after some time on the surface of the milk is evaporated to dryness, an appreciable quantity of fatty matter is left behind. This is not more than might be expected; for the milk in the udder of the cow to some extent becomes agitated by every violent movement of the animal. For this reason, whether butter or cheese be our object, we should endeavour to keep milking-cows as quiet as possible.

Composition of Skim Milk.—As cream-globules are lighter than milk their removal must increase the density of the remaining milk.

Good new milk, on an average, has a specific gravity varying from 1·030 to 1·032. If it is rather poor in cream, but not diluted with water, its specific gravity rises a little; and if it is very rich in cream, the gravity of the milk will sink to 1·029 or 1·028.

I have carefully determined the specific gravity of the two samples of skim-milk, the analysis of which is stated below. At 62° Fahr. the first sample had a specific gravity of 1·037; and the second sample, at the same temperature, a gravity of 1·0337:—

Composition of Skim-milk.

	No. 1.	No. 2.
Water	89·65	89·40
Butter (pure fat)	·79	·76
Casein	3·01	2·94
Milk-sugar	5·72	6·05
Mineral matters (ash)	·83	·85
	<hr/>	<hr/>
	100·00	100·00
*Containing nitrogen	·48	·47

If the cream is imperfectly removed, the skim-milk naturally will be all the better. The following analysis represents the composition of imperfectly skimmed milk :—

Water	.. .. .	89.00
Butter (pure fat)	.. .. .	1.93
*Casein	.. .. .	3.01
Milk-sugar	.. .. .	5.28
Mineral matters (ash)	.. .. .	.78
		<hr/>
		100.00
*Containing nitrogen	.. .. .	.48

On the Circumstances by which the Quality and Quantity of Milk are modified.—In directing attention to this point, I propose to refer to experiments lately made by myself, and to several important and accurate experiments which have been made on the Continent, but which have not, as far as I am aware, appeared in print in England, adding a very brief notice of some well known facts to give completeness to my statement.

Amongst other circumstances, the following affect the quality or the yield of milk :—

1. *The Period of the milking at which it is taken.*—I have stated before that a mechanical separation of the cream-globules from the milk, and a partial disruption of their shells, already begin in the udder of the cow.

The milk which is first drawn off is thin and poor, and gives little cream. That which is last drawn—the strippings—is rich in cream, and yields consequently much butter. The quality of the cream from the strippings also is richer than the rest. On this point experiments have been lately made in France by M. Reiset, who obtained the following results in three different experiments :—

100 parts of Cow's milk contained :—	First Drawn.	Last Drawn.	First Drawn.	Last Drawn.	First Drawn.	Last Drawn.
Water	85.63	81.07	90.10	84.15	88.99	82.37
*Solid matter	14.37	18.93	9.90	15.85	11.01	17.63
	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>
*Containing butter}	100.00	100.00	100.00	100.00	100.00	100.00
(pure fat) }	5.90	10.50	1.80	6.60	2.20	8.80

Similar results were obtained by Pélilot on the examination of ass's milk. In 100 pints of ass's milk Pélilot found :—

	In the Beginning of Milking.	In the Middle of Milking.	At the End of Milking.
Butter	0.96	1.02	1.52
Sugar	6.50	6.48	6.45
Casein	1.76	1.95	2.95
	<hr/>	<hr/>	<hr/>
	9.22	9.45	10.92

This superior richness of the last-drawn milk has an important bearing on the question of using milking-machines. Unless these can finish as well as commence the operation, they will be but of little service to the large dairy farmer. But, according to the united testimony of all who have tried the new American cow-milking machine, one of its greatest defects is that it does not completely strip the udder of its contents. This appears to me fatal to its ultimate success in England; and I am told by the secretary of one of the most influential State Agricultural Societies that it has almost entirely gone out of use in the United States.

The want of success with which this machine has been tried by men who I know are most anxious to do away, if possible, with milking by hand, is no doubt the reason why so little has been heard of it lately. It has been to my knowledge tried by several excellent judges; but as it is at all times a more pleasant task to praise than to condemn,—and judicious men will not bestow undeserved praise, and yet do not like to give an adverse judgment on an implement so much needed as a truly good milking-machine,—they prefer to remain silent on the subject.

2. *Distance from the Time of Calving.*—The first milk, or colostrum, yielded by the animal after the birth of its young, is thicker and yellower than ordinary milk, coagulates by heating, and contains an unusually large quantity of casein or curd, as will be seen by the following analysis by Boussingault:—

Composition of Colostrum, or First Milk of the Cow.

Water	..	..	..	..	..	75·8
Butter (pure fat)	..	..	..	..	..	2·6
Casein	..	..	..	..	..	15·0
Milk-sugar	..	..	..	..	..	3·6
Mineral matters (ash)	..	..	..	..	..	3·0

100·0

In ten or twelve days from the time of calving, this peculiarity disappears, and the milk assumes its ordinary condition. The flow of milk then becomes very plentiful; but after a month, or thereabouts, the yield gradually diminishes, and gets less and less as the time advances.

In the first and second months after calving, when the yield of milk is abundant, it is generally more watery than after the fourth or fifth month. The further the diminution in quantity proceeds, the better the quality of the milk becomes, other circumstances being equal. Most cows run dry in about ten months, but there are exceptions to this rule. By feeding them upon brewer's grains, distillery refuse, succulent grass, mangold-tops, starch-maker's waste, and similar watery food, the milksellers near large towns often keep cows in a profitable milking condition for a very much longer time.

3. *Season of the Year and Food.*—In the spring of the year and the early part of summer, milk is more abundant and of a finer flavour. As the season advances, the supply diminishes, but becomes richer in butter. Thus two samples from the same dairy and cows out in grass, analysed by me in August and in November, yielded the following results:—

				Milk Analyzed Aug. 7.	Milk Analyzed Nov. 29.
Water	..	..	..	87.40	85.21
Butter (pure fat)	..	..	..	3.43	4.95
Casein	..	..	..	3.12	3.66
Milk-sugar	..	..	..	5.12	5.05
Mineral matters (ash)	..	..	..	.93	1.13
				100.00	100.00
Percentage of dry matters				12.60	14.80

The same quantity of milk, it will be seen, which in August scarcely yielded 3 per cent. of pure butter and 3 per cent. of curd, in November produced $1\frac{1}{2}$ per cent. more butter, and $\frac{1}{2}$ per cent. more curd. Cheese-makers are well acquainted with the fact, that in autumn the quantity of milk diminishes considerably, but that the weight of cheese which can be made from a given quantity of milk is much greater than in spring or summer.

COMPOSITION OF MORNING'S AND EVENING'S MILK produced on the
ROYAL AGRICULTURAL COLLEGE FARM, CIRENCESTER.

		Percentage of					
		Water.	Butter (pure fat).	Casein and Albumen.	Milk-sugar.	Mineral Matters (ash).	Nitrogen.
January	Morning..	87.70	2.60	2.94	5.82	.94	.47
	Evening..	87.40	2.28	2.87	6.56	.89	.46
February	Morning..	87.50	2.53	3.44	5.44	1.04	.55
	Evening..	86.40	3.53	3.37	5.56	1.14	.54
March	Morning..	88.60	2.71	2.43	5.35	.91	.39
	Evening..	88.16	2.96	2.62	5.55	.77	.42
April	Morning..	87.50	3.15	2.94	5.60	.81	.47
	Evening..	89.00	2.47	2.69	5.08	.76	.43
May	Morning..	88.20	2.42	3.12	5.49	.77	.50
	Evening..	87.80	2.71	2.87	5.85	.77	.46
June	Morning..	87.30	3.05	3.00	5.89	.76	.48
	Evening..	87.30	2.94	2.87	6.05	.84	.46
July	Morning..	88.70	2.22	2.94	5.38	.76	.47
	Evening..	87.80	3.61	2.81	5.10	.68	.45
September	Morning..	89.91	1.99	2.94	4.48	.64	.47
	Evening..	90.70	1.79	2.81	4.04	.66	.45
October	Morning..	87.60	3.90	2.87	4.84	.79	.47
	Evening..	90.30	2.99	2.37	3.76	.58	.38
November	Morning..	87.10	3.41	2.94	5.41	1.14	.47
	Evening..	86.20	3.78	3.19	5.68	1.15	.51
December	Morning..	86.70	3.74	2.87	5.92	.77	.46
	Evening..	86.00	4.12	3.62	5.46	.80	.58

I here introduce a series of milk analyses (p. 302) which I made with a view of ascertaining what may be the variations in the quality of the milk on one and the same farm throughout the year. I took samples of the mixed milk of all our milking-cows, and analysed the morning's and evening's milk of the first or second day in each month separately. In August, owing to my absence from home, the analyses were omitted. They, and a few other analyses of morning's and evening's milk from other farms, set at rest the question, whether the former or the latter is the richer of the two.

The milk-cows were out in grass from May till the end of October; but as the herbage then became so scarce as not to afford sufficient nourishment, they were fed in the evening in the stall, with roots and hay, &c. It will be seen that both the morning's and evening's milk in September was extremely poor. The cows were then out in grass, but the pasture was poor and overstocked, so that the daily growth of grass furnished hardly enough food to meet the daily waste to which the animal frame is subject, and was thus not calculated to meet an extra demand of materials for the formation of curd and butter. The poverty of this milk thus was evidently due to an insufficient supply of food. In the same month (September) I procured samples of milk from two other farms, on which the cows were out in grass, having an abundant supply of grass of good average quality. The morning and evening milk from each farm on analysis furnished the following results:—

	No. I.		No. II.	
	Morning's Milk.	Evening's Milk.	Morning's Milk.	Evening's Milk.
Water	87.07	87.20	87.50	87.70
Butter	3.44	3.76	3.10	3.59
Casein	3.37	3.35	3.45	3.37
Milk-sugar	5.38	4.98	5.18	4.57
Mineral matters (ash) .. ..	.74	.71	.77	.77
	100.00	100.00	100.00	100.00
*Containing nitrogen ..	.53	.54	.52	.54

These analyses do not show any great difference, and prove that the quality of the September milk was good, and nearly the same on both farms; but compared with the September milk of the cows on the Agricultural College Farm striking differences manifest themselves, indicative of the influence of food on the quality of the milk. Thus, on the farms on which the cows were provided

with abundance of grass the amount of solid matter, on an average, was about $12\frac{1}{2}$ per cent. ; and in this dry matter we have $3\frac{1}{2}$ per cent. of butter, and about the same quantity of curd ; whereas a scanty supply of grass produced milk containing not quite 10 per cent. of solid matter, and in this not quite 2 per cent. of butter.

The influence of food on the quality of the milk is also clearly visible in the October milk of the cows at the Agricultural College. On account of the deficiency of the herbage the cows were in the evening driven into the stall and there supplied with hay, roots, and meal. The milk became better at once ; for the morning's milk then contained $12\frac{1}{2}$ per cent. of solid matter, and in this nearly 4 per cent. of butter. The concentrated food with which the cows were fed at evening was clearly made into good rich milk during the night. At this time the cows were put on grass early in the morning, and allowed to pick up what they could : this was not much, as their anxiety towards evening to be led into their stalls plainly showed. The influence of a stinted supply of grass is seen at once in the poverty of the evening's milk, in which the percentage of solid matter sank to $9\frac{1}{2}$ instead of $12\frac{1}{2}$, and the butter from 4 to 3 per cent. In November, December, and the following winter months, the cows were kept altogether indoors, and fed upon roots, oilcake, straw, and hay-chaff. In consequence of the better food the milk became more abundant and richer. In February the food of the cows in-milk, as Professor Coleman informs me, was as follows :—

At $6\frac{1}{2}$ A.M. 12 lbs. of hay.

„ 9 „ 15 lbs. of mangolds cut fine and mixed with $3\frac{1}{2}$ lbs. of straw-chaff and 1 lb. of hay-chaff.

„ $11\frac{1}{2}$ „ 4 lbs. of rape-cake.

„ $3\frac{1}{2}$ P.M. 15 lbs. of mangolds cut fine and mixed with $3\frac{1}{2}$ lbs. of straw-chaff and 1 lb. of hay-chaff.

„ 5 „ 12 lbs. of hay.

In November and December the cows had given to them some nut-meal in addition to their other food. The influence of the fatty matter in which this meal is rich is seen at once in the larger amount of butter in the milk. This nut-meal is the refuse which is left after pressing the ground kernels of the palm-nut. When of good quality, that is to say, not too hard pressed, it is very nutritious, and contains a large proportion of fat, as will be seen by the following analyses of two samples which were made by me some time ago :—

Composition of Palm-nut kernel-meal.

	No. 1.	No. 2.
Water	9.85	7.01
Fatty matters	24.14	22.45
*Albuminous compounds (flesh-forming matters)	16.43	12.90
Gum, sugar and digestible fibre	26.60	26.81
Woody fibre (cellulose)	19.58	27.70
†Mineral matters (ash)	3.40	3.23
	100.00	100.00
*Containing nitrogen	2.63	2.02
†Containing sand .. .. .	.63	.97

The first sample is the better of the two, for it contains more oil and more flesh-forming matter than the second, in which the percentage of both is lowered by the larger proportion of the hard shells in which the palm-nut kernels are encased. These hard shells, like nut-shells, consist almost entirely of woody fibre, and of course have no feeding value whatever. The fatty matter in palm kernels is a white, nicely-tasting fat, of almost the same consistency as butter.

The time at which the milk is drawn from the cow is said to have an effect upon its quality. The popular opinion ascribes to morning's milk better quality than to that obtained in the evening. My results do not favour this all but generally received opinion. As far as my experience goes, the result depends on the quantity and quality of the food which is given to the cows four or five hours before milking. If the supply of food given in the daytime be good and plentiful, and that furnished in the evening be innutritious and scanty, the evening milk is of the better quality. On the other hand, when the cows get a good supply of rich food in the evening, and are stinted or fed upon very watery food during the daytime, the evening milk is the poorer. Hence it may and does happen that at one time the evening milk is the best, at another the reverse is the case, or else there is no perceptible difference.

My friend and former colleague, Mr. Coleman, has taken much interest in these milk-experiments, and I feel indebted to him for the hearty co-operation and practical assistance which he rendered me at all times during our former connection with the Royal Agricultural College.

The preceding experiments furnish conclusive evidence of the influence of food upon the quality of milk, and afford an explanation of the variations which arise. Without giving additional analyses bearing on this point, I may state that out of 32 samples taken in the morning and the evening of the same day, I found in 8 cases the morning milk poorer than that of the evening; in 4 cases richer; whilst in 4 there was no perceptible difference.

x 2

On the influence of food on the quantity and quality of the milk, we possess valuable practical experiments by the late Mr. Horsfall, of Burley Hall, Yorkshire, whose paper on Dairy Management in this Journal should be attentively studied by every dairy farmer; experiments by Mr. Cunningham, of Audley (Cork), and a few others, may also be found recorded in our Agricultural Journals. For this reason I shall pass them by and direct attention to a series of valuable experiments, which were made in 1855, by Mr. Struckmann, of Wartburg, in Germany. Their object was to determine what quantity of brewers' grains are necessary to replace 1 lb. of rape-cake, and also the comparative practical effect of the same amount and quality of food upon good and bad milking cows.

Accordingly four good and four bad cows, all of which had calved some weeks before, were put up on the 22nd of February, and fed as is stated in the subjoined condensed table. The weight of the animals was ascertained from time to time, the milk carefully measured each day, and the amount of butter which it produced noted down. The following were the results:—

Experimental Periods.	Duration of each Experimental Period.	Daily Food per Cow in each Period.	Average Weight per head.		Daily Average Yield of Milk.		Daily Produce in Butter from the Milk of 8 Cows.
			Superior Cows.	Inferior Cows.	Superior Cows.	Inferior Cows.	
		lbs.	lbs.	lbs.	Litres.*	Litres.	lbs.
I.	{ 22 Feb. 1 March	18 Brewers' grains	1065	1039	43·6	29·5	3·4
		36 Mangolds	1087	1042			
		25 Oat-straw					
II.	19 March	5·4 Rapecake			46·5	30·5	3·8
		36 Mangolds	1097	1072			
		25 Oat-straw					
III.	27 March	4·5 Rapecake			43·4	29·2	3·6
		36 Mangolds	1118	1085			
		25 Oat-straw					
IV.	5 April	18 Brewers' grains			40·9	28·7	2·9
		36 Mangolds	1112	1118			
		25 Oat-straw					
V.	14 April	18 Brewers' grains			37·9	27·7	2·9
		45 Mangolds	1094	1086			
		25 Oat-straw					
VI.	22 April	12 Brewers' grains			33·9	26·0	2·7
		45 Mangolds	1116	1098			
		25 Oat-straw					

The brewers' grains contained 79 per cent. of water.
It appears from these experiments:—

* 1 Imperial Gallon = 4½ Litres.

1. That most milk was produced by $5\frac{1}{2}$ lbs. of rape-cake, 36 lbs. of mangolds, and 25 lbs. of oat-straw.

2. That a reduction of $\frac{9}{10}$ lb. of rape-cake in the daily food per cow diminished a good deal the milk of the superior cows. The 8 cows in the third period yielded 4.4 litres less milk per day, 0.55 litre per cow. According to these results 1 lb. of rape-cake produced on an average $1\frac{1}{3}$ lb. of milk.

3. In the sixth series of experiments, it will be seen, the cows received 6 lbs. less brewers' grains per head than in the fifth series. This diminished the produce in milk to the extent of 0.72 litre. It thus appears that 1 lb. of brewers' grains produced about $\frac{1}{4}$ lb. of milk.

4. In the first and third series of experiments very nearly the same amount of milk was produced. In both sets of experiments the same quantity of mangold-wurzel and oat-straw was given, and the 18 lbs. of brewers' grains given in the first series were replaced in the third by $4\frac{1}{2}$ lbs. of rape-cake. Accordingly 1 lb. of rape-cake was equivalent to 4 lbs. of grains in its power of producing milk.

5. Rape-cake produced milk richer in butter than that obtained from cows fed upon brewers' grains. The butter in the latter case, however, was more delicate in flavour.

6. The modifications in the daily rations of food had far less influence on the yield of milk from the inferior than from the superior cows. Whereas the latter produced decidedly more or less milk according to the food upon which they were kept, the yield of the inferior cows was pretty constant.

7. It will be seen that from the 1st of March to the 5th of April the 4 superior cows gained in live-weight 100 lbs., and yielded 1558.9 litres of milk; the 4 inferior cows gained in live-weight 304 lbs., and yielded 1032.7 litres of milk. Thus in the course of 36 days the superior cows produced 526.2 litres more milk, and 204 lbs. less live-weight than the inferior cows. $2\frac{1}{2}$ litres or about $5\frac{1}{4}$ lbs. of milk consequently were replaced by 1 lb. of flesh.

These experiments and practical conclusions are taken from an interesting account, including many other feeding experiments, published in an important work, entitled 'Lectures on Agricultural Chemistry, specially in relation to Animal Physiology, by Dr. Grouven, Cologne, 1862.'

4. *The race or breed and size of the animal.*—As a general rule, small races, or small individuals of the larger races, give the richest milk from the same kind of food. Whether it is more profitable to keep small or large sized breeds is another question of which we shall presently speak. Where good quality is the main object, Alderneys perhaps will give most satisfaction,

for they give a richer cream than any other breed in common use in this country. The small Kerry cow and the miniature Bretons also produce extremely rich milk, but of course in much less quantity than the larger breeds. For dairy purposes, in cheese districts, the Ayrshires are justly celebrated; indeed they seem to possess the power of converting the elements of food more completely into cheese and butter than any other breed. The food in their system appears to be made principally into milk and not into meat; consequently they are good milkers, but unlike the short-horns, do not fatten well. Remarkably large quantities of milk have been produced by cows of this breed. Thus a cow bought by the Duke of Atholl from Mr. Wallace, Kirklandholm, and probably in his Grace's dairy at Dunkeld House at the present time, produced 13,456 lbs. or about 1305 gallons of milk from the 11th of April, 1860, to the 11th of April, 1861. If we estimate the value of the new milk at 8d. a gallon, the year's produce would be worth 43l. 10s.

With a view of encouraging this useful breed, the Ayrshire Agricultural Society has an annual milking competition, at which prizes are given for the Ayrshire cows yielding the greatest weight of milk at four successive milkings, and also to cows from whose yield of milk the best return in butter is made. No restriction whatever is placed upon competitors in regard to the keeping of the cows. The following is a statement of the quantities of milk, produced by the cows in the competition of 1861, and of the butter churned from the milk:—

No.	Cow belonging to	Greatest Milking.		Average of Four Milkings.		Weight of Butter.	
		lbs.	ozs.	lbs.	ozs.	lbs.	ozs.
1	A. Wilson	27	12	24	3½	2	2
2	J. Hendrie	26	0	24	5	2	14½
3	W. Reid	25	7	20	8½	2	9
4	W. Reid	30	15	27	5½	3	6½
5	R. Wallace	28	14	28	8½	1	9½
6	R. Wallace	25	5	23	8½	1	15

The short-horn, though more particularly distinguished for its precocity and excellence as a meat-producing animal, is nevertheless an excellent milking cow. Some families of even pure-bred short-horns are, indeed, distinguished in this respect; for, when well fed, they will yield much milk, and at the same time go on improving in condition. On this account they are preferred by many to Ayrshires, Alderneys, and other breeds of peculiar or local merit, and are becoming more and more the principal dairy breed of England.

The Yorkshire cow, essentially a short-horn, is the favourite breed of cow-keepers in London and other large towns, as it

surpasses all others for the quantity of milk it yields. The milk, however, compared with that of the smaller breeds is more watery and less rich in butter, and better suited for direct consumption than for the making of butter or cheese. The statement made by some that pure-bred short-horns are not good milkers, is emphatically denied by others. The truth is, there are short-horns which are good milkers and others which are not, and it remains for the dairy farmer to pick out and propagate those families distinguished rather for milk-producing qualities than for fattening properties. As a rule, animals remarkable for the rapidity with which they put on flesh and fatten are not the best milkers, and *vice versâ*. Short-horns, on the whole, perhaps, are more useful for general dairy purposes than any other breed.

In 1860 I made some experiments with a view of ascertaining whether pure-bred short-horns gave more or less, and better or worse milk, than cross-breds. In the month of September, 1860, 3 cows from the common dairy stock, and 3 pedigree short-horns belonging to Mr. Thomas Proctor, Wall's Court, near Bristol, were kept on the same pasture, and the milk from each set of cows carefully measured and subsequently analysed. The pasture was good and the supply of food unlimited.

The daily produce in milk was as follows:—

Three common dairy cows gave: 31 pints in the morning, 21 pints in the evening, making together 52 pints.

Three pedigree cows gave: 28 pints in the morning, 21 pints in the evening, or together 49 pints.

The common cows thus produced rather more milk, but the differences were trifling.

Composition of Milk of common Cows (on Grass alone) on Sept. 18, 1860.

On evaporation, the morning's milk gave:—

Water	86·7
Dry matter	13·3
	<hr/>
	100·0

The evening's milk:—

Water	86·6
Dry matter	13·4
	<hr/>
	100·0

As there was no appreciable difference in the concentration of the morning's and evening's milk, both were mixed and analysed together, with the following results:—

Water	86·65
Butter	3·99
*Casein	3·47
Milk-sugar	5·11
Mineral matters (ash)	·78
	<hr/>
	100·00

*Containing nitrogen 56

Composition of Milk of Pedigree Short-horns (on grass alone) on Sept. 18, 1860.—The morning's milk of the pedigree cows contained 87·6 per cent. of water, and 12·4 per cent. of dry matter, and thus was less concentrated than the morning's milk from common cross-bred short-horns.

The evening's milk contained 86·8 per cent. of water, and 13·2 per cent. of solid matter, and therefore was about as concentrated as the evening's milk of the common cows.

The following numbers show the detailed composition of this milk in the morning and evening, and the average composition of both :—

	Morning.	Evening.	Average.
Water	87·60	86·80	87·20
Butter (pure fat)	3·56	4·16	3·86
*Casein	3·19	3·37	3·28
Milk-sugar	4·92	4·86	4·89
Mineral matters (ash) ..	·73	·81	·77
	<hr/> 100·00	<hr/> 100·00	<hr/> 100·00
*Containing nitrogen ..	·51	·54	·52

Whether we regard quantity or quality, the 3 cross-breds in these experiments gave rather more favourable results.

After some time all the cows, in addition to grass, received 1 lb. of good linseed-cake per head per day, and then yielded :—

3 common cows ..	28½ pints of milk in the morning and 18 in the evening, or together 46½ pints.
3 pedigree cows ..	26½ pints of milk in the morning and 22 in the evening, or together 48½ pints.

Composition of Mixed Morning and Evening's Milk on Sept. 24, 1860, Cows on Pasture and 1 lb. of Linseed-cake each daily.

	Common Dairy Cows.	Pedigree Cows.
Water	87·10	86·50
Butter	4·28	4·28
*Casein	3·06	3·25
Milk-sugar	4·84	5·30
Mineral matters (ash) ..	·72	·67
	<hr/> 100·00	<hr/> 100·00
*Containing nitrogen	·49	·52
Percentage of solid matter ..	12·90	13·50

The addition of oil-cake appears to have slightly increased the amount of butter in the milk, but not the yield of milk itself. After the cows were kept for a week upon 1 lb. of oilcake and grass *ad libitum*, 2 lbs. of cake were allowed to each animal. The average yield of milk then was as follows :—

3 common cows produced 30 pints in the morning and 19 in the evening, or together 49 pints.
3 pedigree cows produced 26½ pints in the morning and 21 in the evening, or together 47½ pints.

*Composition of the Mixed Morning and Evening's Milk on October 2
(Cows fed upon Grass and 2 lbs. Linseed-cake each day).*

	Common Dairy Cows.	Pedigree Cows.
Water	86.90	86.50
Butter	3.96	4.19
*Casein	3.37	3.19
Milk-sugar	4.98	5.34
Mineral matters (ash) .. .. .	.79	.78
	<hr/> 100.00	<hr/> 100.00
*Containing nitrogen .. .. .	.54	.51
Percentage of dry matter	13.10	13.50

It will be seen that the milk of the cows when kept on grass alone was rich in butter, and generally speaking of more than average concentration. The grass evidently was of good quality, and as the cows had plenty of it, we can well understand that the additional supply of linseed neither increased the yield of milk nor its richness. Indeed the yield of milk slightly diminished in October, when 2 lbs. of oilcake were given, not, I believe, in consequence of the oil-cake, but because with the advancing season, the produce in milk gradually decreases, whilst its richness perceptibly increases.

In the experiments before us, this tendency towards a diminished yield and richer condition may be recognised, though not so distinctly as it no doubt would have been had the trials been continued for a longer period. It is interesting to observe that while these cows fed on good rich pasture in September gave milk containing 13 to 13½ per cent. of solid matter, and about 4 per cent. of pure butter, those kept on the College farm at the same time gave scarcely 10 per cent. of solid matter, and not quite 2 per cent. of pure butter. By pure butter, I mean the pure fatty matters contained in milk; from 8 to 8½ lbs. of which give on an average 10 lbs. of commercial butter.

Large-sized cows produce more milk from the same kind of food than small-sized animals of the same breed.—In proof of this I may mention an interesting experiment made in 1855, by Mr. Ockel, of Frankenfelde, in Germany, with 4 Dutch milking-cows. Two of the cows weighed 2112 lbs. together, and the two others only 1537 lbs. at the beginning of the experiment. The two heavier and the two lighter cows were kept separately, but fed alike with as much green lucerne as they would eat. The food which was supplied to each was carefully weighed, and what was not consumed weighed back each day and deducted. The experiment was continued for a period of sixteen days, and gave the results embodied in the following table:—

	Weight at the Beginning of Experi- ments.	Weight after 16 Days.	Green Lucerne consumed.	Produce in Milk.	Produce in Milk from 100 lbs. Green Lucerne.			Lucerne consumed from 100 lbs. Live- weight.
	lbs.	lbs.	lbs.	galls.	galls.	pints.	ozs.	lbs.
Two heavy cows ..	2112	2102	4921	68	1	3	16	14·6
Two light cows ..	1537	1537	3859	48	1	0	16	16·0

It will be seen that the weight of the cows remained unaltered during the experiment, and that the two heavier cows produced more milk than the two lighter ones; and also that the former gave a better return for the amount of food consumed.

These results agree perfectly with ordinary experience. As a rule, milking-cows of small breeds are not so profitably kept as large breeds; and heavy animals generally give more milk than light or small individuals of the same breed, other circumstances being equal. This no doubt is one of the reasons why cow-keepers prefer tall Yorkshire cows and other large crosses of short-horns to all other breeds.

In the preceding pages attention has been directed to the principal circumstances which affect the composition or quality of the milk. Others might, of course, be mentioned, but such circumstances as the age of the animal, its state of health, general constitution, &c., are too obvious to need any special notice.

On the Adulteration of Milk, and means of Detection.

A great deal has been said and written about milk adulteration. In treatises on this subject almost every writer mentions a number of substances which are said to be used in London and other large towns for this purpose; and yet, perhaps, not one of these materials is really so employed for adulterating milk. In point of fact, sheep's brains, starch, paste, chalk, and other white materials which are said—on what authority nobody has ever decided—to have been found in milk, only exist in the imagination of credulous or half-informed scientific men, who in many cases reproduce faithfully in their writings all the exaggerations and errors of their predecessors.

In large towns and all places where the demand for milk at times is greater than the supply, its quality is not so good as it might be. The inferiority, however, arises simply from a deficiency of cream, and an excess of water. The cow with the iron tail, indeed, is said to be the best friend of the milkman, perhaps not without good reason.

When milk-cows are fed upon distillery waste, bran-mashes,

grass from irrigated meadows, mangold-tops, and acid slops, obtained by allowing barley-meal, cabbage-leaves, &c., mixed with a great deal of water, to pass through the so-called lactic acid fermentation, the milk becomes very watery. Such milk, though unmixed with water, generally is quite as poor as milk which has been purposely so diluted.

The whole question of milk adulterations and means of detecting them resolves itself into an inquiry into the characters of good, bad, and indifferent milk, and the mode of recognising these with precision. As the result of my own experience, founded on the examination of many samples of milk, produced under the most varied circumstances, and purposely adulterated with known quantities of water, I may state that milk may be considered rich, when it contains from 12 to $12\frac{1}{2}$ per cent. of solid matters, and from 3 to $3\frac{1}{2}$ per cent. of pure fatty substances. If it contains more than $12\frac{1}{2}$ per cent. of dry matter, and 4 per cent. or more of pure fat, it is of extra rich quality. Such milk throws up from 11 to 12 per cent. of cream in bulk, on standing for 24 hours at 62° Fahr.

Good milk of average quality contains from $10\frac{1}{2}$ to 11 per cent. of dry matter, and about $2\frac{1}{2}$ per cent. of pure fat. It yields from 9 to 10 per cent. of cream. Milk adulterated with water, or naturally poor, contains more than 90 per cent. of water, and less than 2 per cent. of pure fat. Such milk yields only 6 to 8 per cent. of cream, and even less if it be very poor.

A comparison of the results obtained in the milk analyses embodied in this paper will show that whereas the proportions of curd, milk-sugar, and ash, do not greatly vary in good, bad, or indifferent milk, the percentages of butter (pure fat) in different samples of milk are subject to considerable variations. In other words, the quality of milk depends more on the amount of butter, or rather of cream, which it contains, than on that of any other constituent.

An instrument, therefore, by means of which the percentage of cream could be determined accurately and readily, would be most valuable for the purpose of ascertaining the relative qualities of different samples of milk. *Creamometers* are instruments which have been recommended for that purpose. They are made either in the form of a cylindrical measuring glass, with glass foot, and divided into 100 equal degrees, or in the form of graduated wide glass tubes. The graduations proceed downwards, from a point near the open end, marked zero, and each degree indicates 1 per cent. of cream. A number of these tubes are conveniently kept in a vertical position by a frame fitting into a cylindrical tin box, which, if necessary, may be filled with water of the required temperature (62° Fahr.), and covered with a lid, having an

aperture, through which a thermometer may be inserted, and the temperature of the milk ascertained.

All that is necessary is to fill these graduated tubes up to zero, and after 24 hours to read off the number of degrees occupied by the cream. The milk should be kept during the experiment as nearly as possible at a temperature of 62° Fahr. In using these instruments for comparative trials, it is necessary to observe in the first place that the temperature be the same in all trials, for direct experiments have shown me that somewhat less cream is obtained when the temperature rises above 62° Fahr.; or rather I should say that the cream which is thrown up at a more elevated temperature than 62° Fahr., occupies somewhat less space than that which rises at a lower temperature. In the second place, in all trials the milk should be left standing for the same length of time, which may be either 18 or 24 hours. If left for a longer time I find that the bulk of cream slightly diminishes. During the longer period more cream rises; but as a more complete separation between the liquid portion of milk and the cream globules takes place under these circumstances, notwithstanding the larger amount of cream, its bulk slightly diminishes, as will be seen in the following trials:—

1. 100 measures of new milk yielded in the creamometer 13½ measures of cream after 18 hours; the same quantity after 24 hours, and scarcely 13 measures after 48 hours.

2. 100 measures of another sample of new milk gave nearly the same results.

3. 100 measures of a third sample showed 13 measures of cream after 18 hours; the same quantity after 24 hours, and 12 measures after 48 hours.

There are two circumstances which seriously interfere with the practical use of the creamometer, and make its indications unreliable. The first is that the cream which rises from different kinds of milk often varies greatly in composition. Proofs of this have been given already in the experiments cited in a former part of this communication, by which it was distinctly shown that the largest amount or the thickest cream does not always give most butter. The indications of the creamometer, therefore, are fallible when samples of milk, produced under very different circumstances, have to be tested.

The second disturbing circumstance in the use of this instrument lies in the fact that milk which has been agitated, as it necessarily will be, when sent by rail, throws up less cream than that which has been less disturbed. A direct experiment shows this very distinctly:—

100 measures of new milk, after standing for 24 hours at 62° Fahr., gave 12 per cent. of cream by measure, whilst, at the

same time, a like quantity of the same milk, after having been gently shaken in a bottle, threw up only 8 per cent. of cream.

This shows that, the shaking to which milk is subject when sent by railway, has the effect of breaking some of the cream globules; in consequence of which either the fatty matters remain suspended in the milk, or more probably the cream thrown up gets richer in fat.

Another instrument for ascertaining the quality of milk is *Donné's lactoscope*. It consists of a kind of telescopic tube, through which, when filled with milk, you look at a candle placed at a distance of 3 feet. The more opaque the milk is, that is, the richer it is in cream globules, the shorter will be the telescope tube, through which the candle can be clearly seen, and *vice versa*. A graduated index shows the percentage of pure milk in water. *Donné's lactoscope* does not give accurate results, and for this reason has never come into practical use.

Another instrument for determining the amount of butter in milk is *Marchand's lacto-butyrometer*, which is a graduated tube, divided into three parts. The first division is marked "milk," the second "ether," and the third "alcohol." A marked indicator slides up and down the tube. This tube works into a wider tin tube, or casing, which serves as a water-bath when the milk is tested. The milk is poured into the tube up to the second division, marked "ether;" two or three drops of a solution of caustic soda are added, and then ordinary ether up to the third division, marked "alcohol." The milk and ether are next well shaken together, and afterwards the third division is filled up with spirits of wine, containing from 86 to 90 per cent. of absolute alcohol. When milk is shaken up with ether, its fatty matters are completely dissolved; and on the addition of alcohol, they are again almost entirely precipitated. The quantity of fatty matter which remains dissolved in the ether is said to be constant. *M. Marchand* estimates it at 12.6 grammes per litre of milk. Finally, the tube is plunged into warm water, of a temperature of 104° Fahr., and kept in the heated water until the butter is quite melted, forming a layer, which is readily measured by the sliding indicator.

Marchand's lacto-butyrometer requires much dexterity on the part of the operator, and therefore is not likely to be used by persons who have no experience in chemical manipulation. In the hands of a professional chemist this instrument furnishes tolerably accurate results.

M. Poggiale tests the quality of milk by determining the amount of milk-sugar, either by polarization, or by *Fehling's volumometrical copper test*.

M. Emile Mounier, on the other hand, has lately described a plan of testing the quality of milk by determining the amount of albumen and casein in it by a standard solution of hypermanganate of potash.

As both Paggiale's and Mounier's methods are based on wrong principles, the particulars of their processes need not be described in this place.

M. Quévenne uses two instruments for testing milk; one of which he calls "lacto-densimeter," and the other creamometer.

The lacto-densimeter is an instrument similar to a spirit-float. The narrow tube of this float bears two scales. One is coloured yellow, and indicates the specific gravity of new milk; and the other is coloured blue, and is used for ascertaining the specific gravity of skimmed milk. The degrees on the yellow and blue-coloured sides give in a direct way the specific gravity of new and skimmed milk.

Quévenne's creamometer is simply a graduated measuring glass, divided into 100 parts. On both scales the gravity of both new and skim-milk, when pure, is marked; and also the specific gravity of milk diluted with 1-10th, 2-10ths, and more of water.

Chevallier's *galactomètre centésimale* consists of a densimeter, thermometer, and creamometer, and its construction is based on the same principle as Quévenne's instrument. Like Quévenne, M. Chevallier has two scales on his densimeter, one for new, and the other for skim-milk. Except in the mode in which the scales are divided, Chevallier's and Quévenne's milk-testers do not differ from each other. In pure milk the densimeter sinks to a point marked 100; and the number of degrees on the scale indicate the percentage of pure milk in milk of any quality. Thus, if the densimeter sinks in two samples of milk to a point marked on the scale 50 or 76, these numbers indicate that the samples contain 50 and 76 per cent. of pure milk.

Any ordinary hydrometer for liquids heavier than water may be used for testing milk; but those hydrometers which indicate the specific gravity at once are preferable to others the use of which necessitates calculation or reference to tables.

Hydrometers specially adjusted for testing milk, or lactometers, indicating by the point to which they sink in different samples of milk, the extent to which they have been mixed with water, are sold at a cheap rate by Mr. J. F. Griffin, 119, Bunhill-row, and other manufacturers and dealers in chemical and philosophical apparatus. These lactometers, or floats, are far more useful than I was inclined to think they were, before I had thoroughly

studied how far the specific gravity of milk can be relied upon as an indication of its quality.

A good many recent experiments have led me to the conclusion that within certain limits the specific gravity is a trustworthy indicator of quality. It is true that the cream globules are lighter than milk, and thus milk containing much cream has a lower specific gravity than skim-milk; but surely no instrument is required to tell us whether milk is extra rich, or, like skim-milk, poor in cream. The lactometer was never intended to indicate the relative richness of extra good samples of milk, but it was designed to be a simple instrument which should unmistakably point out whether samples of a fair or doubtful appearance had been watered, or were of a naturally defective composition; and this purpose it satisfactorily fulfils.

Some of the objections to the use of hydrometers for testing milk, are based on the mistaken opinion that cream is lighter than water. This is not the case; it is lighter than milk, but denser than water, in the proportion of 1012, or even 1019 to 1000. The addition of cream, therefore, cannot depress the specific gravity of the milk in the same degree as the addition of water. A low specific gravity, therefore, always indicates a large quantity of water; at all events I find milk rich in butter, of a gravity that is a good deal higher than milk adulterated with even little water.

I will conclude with a few experiments, showing the quantity of cream which is thrown on the surface by pure milk of known composition, and milk purposely adulterated with fixed quantities of water, and also the specific gravity of milk adulterated with variable portions of water.

The milk used on the 4th of March had the following composition:—

Water	86.80
Pure fat (butter)	3.71
*Casein and albumen	3.37
Milk-sugar	5.31
Mineral matters .. .. .	.81
	<hr/>
	100.00
*Containing nitrogen .. .. .	.54
Percentage of solid matter	13.20

This milk had a specific gravity of 1.0320 at 62° Fahr. After standing for 15 hours it threw up 11.5 per cent. of cream by volume, having a specific gravity of 1.0183 at 62° Fahr.

Portions of milk were mixed with 10, 20, 30, 40, and 50 per cent. of water respectively, and the specific gravity of each sample thus diluted with water compared with that of pure milk, when the following results were obtained:—

	Specific Gravity.	Percentage of Cream in bulk.
Pure milk at 62° Fahr.	1·0320	11½
„ and 10 per cent. of water at 62° Fahr. ..	1·0315	10
„ 20 „ „ „	1·0305	9
„ 30 „ „ „	1·0290	8
„ 40 „ „ „	1·0190	6
„ 50 „ „ „	1·0160	5

After removal of the cream from each sample, the specific gravity of the skim-milk at 62° Fahr. was determined, and found as follows:—

Pure skim milk	1·0350
„ and 10 per cent of water	1·0320
„ 20 and 30 per cent. of water (spoiled by accident).	
„ 40 per cent. of water	1·0210
„ 50 „ „	1·0180

In the preceding experiments the specific gravity of the milk was determined by means of an hydrometer. But as results obtained in this way are not considered so accurate as determinations made by direct weighings on a delicate balance; and, moreover, as the second of the series accidentally failed, I made a new set of experiments on the 25th of March last.

The milk was analysed, and had the following composition:—

Water	88·10
Pure fatty matters (butter)	2·61
*Casein and albumen	3·12
Milk-sugar	5·46
Mineral matters (ash)	·71
	<hr/>
	100·00
*Containing nitrogen	·50
Percentage of solid matter	11·90

Its specific gravity at 62°, ascertained by hydrometer, was 1·0320; and by direct weighing 1·03141. After standing 24 hours it gave 12 per cent. of cream by volume; having been shaken, and then left to stand for 24 hours, it gave 8 per cent. of cream by volume.

	Percentage of Cream by bulk.
This milk and 10 per cent. of water, after 24 hours' standing at 62°, gave 10½	
„ 20 „ „ „	10
„ 30 „ „ „	6
„ 40 „ „ „	5
„ 50 „ „ „	4½

The relative proportions of cream in these samples do not agree with the amount of water that has been purposely added to each. I account for these variations by the fact that in mixing the milk and water together, the cream globules have been more or less

broken, according to the degree of agitation to which the milk was exposed, in consequence of which the cream in the different samples had a variable composition.

On comparing the milk of the 25th of March with that of the 4th of March, it will be seen that the latter, notwithstanding its containing more pure fatty matter, threw up a little less cream in bulk than the former.

The subjoined table gives the specific gravity of the different samples of milk of the 25th of March, before and after skimming. All determinations were made at 62° Fahr. :—

	Specific Gravity at 62° F. before skimming.		Specific Gravity at 62° F. after skimming.
	By Hydrometer.	By Direct Weighing.	By Direct Weighing.
Pure milk	1·0320	1·03141	1·0337
" + 10 per cent of water ..	1·0285	1·0295	1·0308
" + 20 " " ..	1·0250	1·0257	1·0265
" + 30 " " ..	1·0235	1·0233	1·0248
" + 40 " " ..	1·0200	1·0190	1·0208
" + 50 " " ..	1·0170	1·0163	1·0175

This second series of experiments was made with great care, and the numbers obtained are probably more reliable than those of the first series.

It will be seen that the hydrometer indications agree very nearly with the specific gravity determinations by direct weighings. It follows, further, from the preceding experiments :—

1. That good new milk has a specific gravity of about 1·030.
2. That skim-milk is a little more dense than new milk, its specific gravity being about 1·034.

3. That milk which has a specific gravity of 1·025, or less, is either mixed with water, or naturally very poor.

4. That when milk is deprived of about 10 per cent. of cream by bulk, and the original volume is made up by 10 per cent. of water, the specific gravity of such skimmed and watered milk is about the same as that of good new milk.

5. That when unskimmed milk is mixed with only 20 per cent. of water, the admixture of water is indicated at once by the hydrometer, which gives for such milk a specific gravity of about 1·025.

6. That for these reasons the hydrometer, or "lactometer," which gives the specific gravity of milk, is well adapted for detecting the admixture of water in milk, or to show an unusually poor condition of undiluted milk.

In conclusion, it may be stated that the facts mentioned under
VOL. XXIV.

Y

No. 4 do not by any means prove that the hydrometer gives unreliable results; for although it is quite true that by substituting 10 per cent. of water for 10 per cent. of cream, the original gravity of the new milk is preserved, it may be observed that milk skimmed to that extent cannot be mixed with water without becoming so blue and transparent that adulteration cannot be practised. At all events if it should occur, no instrument whatever is required to detect it.

12, Hanover-square, London, July, 1863.

XX.—*The Results of Steam Cultivation.* By W. J. MOSCROP.

PRIZE ESSAY.

It has been remarked, to the disparagement of the farmer, that while in the course of the last half-century every other industrial class of the community have found the means to lessen the expense of producing their articles of commerce, he stands alone a notable exception, his working expenses not having been sensibly diminished.

Perhaps this assertion may be in the main correct, and the gross outlay incurred in the production of a quarter of wheat may be as great now as it was fifty years ago; but can this be a matter of wonder when the great item of expense in its production is labour, and while, besides the increased cost of manual labour, the farmer's choice of traction power was confined to the sluggish ox or grain-consuming horse?

If we take as our point of departure the institution of the Royal Agricultural Society, there can be no doubt that from that period great advances have been made, and much ingenuity displayed in the invention of new cultivators, as well as in the improved construction of our standard implements; yet, whatever be the extent of these improvements, it is clear that while the farmer lacked a cheap traction power, his means of economising were but slight. After years of experiment, expensive and laborious, that all-powerful, untiring agent, the steam-engine—the great abridger of time and labour—is now about to prove to the farmer as tractable and serviceable in the field, when attached to the plough, as it has hitherto been while setting in motion the various machinery of the farm-yard.

In the following pages the writer proposes to state in detail the results of steam cultivation on a clay soil which have come under his own observation within the last three years; for defects in style and composition he asks the reader's indulgence, as he lays no claim to literary ability. The most valuable part of our

modern agricultural literature probably consists of the recorded experience of practical men—men who, at a risk of loss to themselves, have diverged from the beaten track, acting as pioneers for their neighbours, and, whether successful or otherwise, have dared to give in faithful detail the various results of their experimental practice.

PRACTICAL DETAILS.

In order to arrive at an approximate estimate of the value of an act of cultivation, it is essential to have a general idea of the physical constitution of the soil operated on. This will furnish a key to many difficulties—a touchstone that will reconcile many apparent anomalies and contrarieties. Clay, loam, sand, are only relative terms; a soil, for instance, that cultivators of one district might term loam, would differ materially from that which would be so classed in another district. Hence to take the acreage got over as a test of the economy of cultivation, irrespective of the nature of the soil, may be delusive, since this is no definite measure of the amount of resistance overcome. In estimating in different districts the respective value of steam or any other mode of cultivation, these premises should be borne in mind.

The soil on which our experience has been gained is derived from, and in its composition partakes largely of, the Oxford clay. The subsoil—the clay proper—is extremely stiff, close, and impervious, and is covered by the surface-soil to a depth varying from 4 to 7 inches. On this geological formation, where the parent clay predominates in the composition of the surface, the soil formed is invariably very retentive and tenacious, and therefore difficult and expensive to cultivate. Its natural characteristics have been aptly described by the remark “that in winter, such soils are like glue, and in summer, cast-iron.”

We had hoped to have given the dynamometrical measure of the draught for a common plough at a given depth, but circumstances prevented this. To practical men, however, the number of horses usually required in a plough will convey a fair idea of the nature of a soil; and when we mention that on the class of soils to which our remarks refer, three, four, five, and occasionally six horses, may be seen in a plough, it will readily be inferred that they may properly be classed as strongest among the strong.

In our practice three horses are required for common seed-furrow ploughing; while for deep work (9 and 10 inches) it is found extremely hard work for four horses to get over three-quarters of an acre per day.

These horses, be it observed, are not specimens of the poor, badly-fed animals which are so frequently seen as a characteristic feature on the small farms in clay districts, but well fed and

powerful, and they are attached two abreast to the best implements furnished by Messrs. Howard and Hornsby.

If the labour of a horse be set at 3*s.* 6*d.*, and a four-horse team be supposed to average three-quarters of an acre per day, the cost of this deep ploughing will amount to 18*s.* 8*d.* per acre. This to farmers of some districts will seem a fabulous sum, but we feel certain our assertion will neither merit nor meet with contradiction from our neighbours, when we affirm that the actual average cost of ploughing 9-inch deep on such soils is considerably over, rather than under, 20*s.* per acre.

The foregoing remarks, illustrating the composition and character of the soil to which our subsequent statements refer, are further necessary, as affording data by which ultimately to compare the cost of its cultivation by horse and steam-power.

To enter into the merits of the different rival makers and their various modes of applying steam to the cultivation of the soil, is for our present purpose as unnecessary as it would be invidious. There is ample scope for the employment of all, and, with varying circumstances and situations, each may possess some special recommendation; while the numerous facts already before the public will enable any intelligent man to choose the implement and mode of traction best adapted to the peculiarities of his farm.

Our experience has been confined to cultivation with a Fowler's 12 horse-power engine and balance-power, and consequently our remarks and deductions are entirely confined to, and drawn from, that experience. We do not disparage the success of other makers, and, however desirable it might be to draw a comparison between the results of the cost of the different systems in use, it would be extremely difficult to arrive at any reliable conclusion. But as to the beneficial results obtained no such difficulties present themselves; and if with Fowler's mode of application better crops are obtained, we may safely assume that there would be no material difference from the use of an implement on the Smith or Howard principle.

Our first essay in steam culture was made in the year 1860,—an era memorable to occupiers of clay, not only for the excess of rainfall,* but the absence of sun, when the continuous cloudy moist weather kept retentive soils in so wet and raw a condition, that the intervals in which they were in a state suitable for cultivation were very brief indeed.

We have heard it advanced as an argument in favour of steam-ploughing, that it may be carried on when the soil is too wet for the employment of horses. Our experience is, however, against this, for we have found it possible to flounder on with horses long

* The average rainfall of the county for a series of years previous to 1860 was 22.129 inches; in that year the fall was 29.20.

after steam has been obliged to quit the field. We do not adduce this to the prejudice, but rather as an argument in favour of steam; for though horse-ploughing *may* be done at such a season, yet it is clear, that if the soil is so wet that the steam-cultivator clogs or cuts into it, however possible it may be to continue horse-work, yet on *clay soils* it can only be labour lost, and worse than useless.

In the year mentioned our steam-ploughing commenced early in April; and although during the summer frequent stoppages arose through wet, the greater portion of the season's work was done then, as the total autumnal ploughing amounted to 45 acres only.

The number of days in which the tackle was at work cannot now be stated with certainty; but the average work done per day, including removals, was certainly under three acres. The total acreage ploughed was 309 acres, and the impression left on the mind at the end of our first year's experience of steam cultivation was, that it had not proved a remarkable success.

But besides the wet season, there were other extenuating circumstances to account for this bad work; viz., that all the land had been drained the previous winter, and many stoppages arose from the plough getting embedded in the drains, sometimes so deeply as to require the use of the screwjack to help it out. The frequent occurrence of such accidents tended to make the engineer reckless in driving, so that occasionally, on finding the implement fast, he turned on the whole force of the steam (a pressure of 80 lbs.), and if the plough or rope did not succumb to the repeated tugs of a power little short of 20 horses, perhaps the anchor did, and, tilting over, rendered confusion worse confounded.

Another fertile source of hindrance was from breakages, chiefly of shares and skyfes, which were fractured by collision with roots which had been left behind in grubbing up some miles of hedgerows when steam cultivation was adopted. Moreover this clay soil, when undrained, had necessarily been ploughed into high narrow ridges, with deep furrows, which very much hindered the working of the plough, because in crossing them, to secure cultivation in the furrows, it became necessary to stir the ridges to a great depth, whereby the working of the engine was made very irregular, and much wear of the working parts as well as loss of time involved.

These annoyances, though seemingly small things, will yet in the aggregate be found of considerable importance, and such drawbacks will probably be encountered by many in the first stage of their experience, and more especially by those who select a clay district as the field of their operations.

Where a hedgerow has been recently grubbed, before crossing its site with the steam-cultivator we now invariably have it deeply

ploughed with horses, followed by a man with a grub-axe, to eradicate any root that may have been overlooked in grubbing; yet, notwithstanding the utmost care, breakages of some sort usually occur in the first crossing.

Across the deep-furrowed ridges the smooth working of the plough will be much facilitated by commencing at the furrows with a horse-plough and going two or three times round them, which not only tends to level but also ensures their thorough cultivation.*

Our second season gave as a result 631 acres ploughed, the average, including removals, being rather over four acres per day.

The work of our last season commenced on the 2nd day of May, and terminated on the 21st day of November, 1862. The number of days in which steam was got up for work or removal was 129. On two of those the fire was put out after trial, on account of the land being too wet for work. On two days a stoppage took place when about half a day's work had been done, from a defect in the pump. We had five broken days from rain, the men making time for three days out of the five. If from the 129 we deduct 5 for lost time, we have remaining 124 days in which was completed the work of the season, amounting to 502 acres, averaging a little over four acres per day.

Of these upwards of 400 acres were worked to a full average depth of 9 inches, and the remainder about 7 inches. Since we did not find any difference in the power required to move the implement, whether it was fitted up with mouldboards as a plough or with short breasts and used as a scarifier, there is no need to distinguish the amount of work done by either mode.

To those familiar with the annals of steam-cultivated farms, as recorded in the columns of our weekly agricultural journals, this average will seem a very poor one; but acreage alone is no criterion of the extent of the work done, whilst it will be seen, from figures hereafter detailed, that even with this seemingly small average the economy of steam-power in comparison with horse-work has been very considerable.

BREAKAGES AND STOPPAGES.

If, as subsequent details show, we estimate our daily outgoings when at work with the steam-plough at 50s., it is clear that when hindrances or stoppages are of frequent occurrence, the economy of the system will be endangered.

Any farmer who has studied the labour-question, especially that of horse-labour, and has felt how results are stealthily im-

* If the drains had been treated in the same manner, like results would have followed.—T. O. W.

paired and calculations upset by mishaps of all kinds, is likely to have his patience taxed by the sight of a plough-team losing time by stoppage. But if the stoppage of one, ruffle his temper, how will he maintain his equanimity if the stoppage of one, disables and stops three? Yet in effect, any little breakage in one part, causing the stoppage of a 12 or 14-horse power steam-plough, really amounts to this. Reckoning, as before, the daily expenses of a day of ten hours at 50s., it follows that for every minute's stoppage that occurs, the employer loses a penny. In this matter time is money, and he whose motto is economy must look ahead and keep his implement moving.

Stoppages are the result of breakages, and the latter may arise from general wear and tear, accident, or carelessness; and while great care should be exercised to confine accidental breakages to a minimum, yet when they do occur the great thing is to have the broken parts replaced or repaired with the utmost dispatch and least possible delay. Every minute is a penny. A large stone or root, we will suppose in the middle of a 400-yard length of cultivation, comes in contact with the cultivator, and a broken share, point, skyfe, or rope-joint, is the result of the collision. If the ploughman is careful and provident, he is provided with a small box fitted on to the plough, in which he carries a spare share, rope-joint, a few nuts and bolts, screw-spanner, &c., so that in the case of a broken share a new one can readily be fitted on in two minutes' time, of which the value is twopence; but if this box is not provided or the necessary duplicates not kept in it, and he has to drag his slow length along to the engine and back, the time lost will certainly exceed ten minutes, and the lost twopence grows into a shilling. Again, perhaps the work has gone on smoothly for some time and no breakage has occurred: the men get careless. 'Why need we trouble ourselves to carry these duplicates to the other field? they are never wanted;' but, behold, some part gives way, and instead of the ten minutes' journey to the engine the last field or the smithy has to be visited, at the loss of half, nay, more likely a whole hour, that is to say, of five shillings.

It is these stoppages that prove the bane of the system, and yet to a great extent the antidotes are simple and within the reach of all, viz., caution and vigilance to prevent accidental breakages, foresight to have in stock the necessary duplicates to replace those when they occur, and promptitude in repairing the damage done. Success mainly depends on the capability and industry of the men working the apparatus, especially if the farmer does not closely supervise it in person. In many instances it is so difficult to get the workmen to appreciate the

value of time, that it is generally found that direct pecuniary interest may well be brought to bear on their minds, as tending much to their enlightenment. By giving a small sum per acre in addition to their fixed wages, a healthy stimulus is created; the men feel that they are associated in the undertaking; and the receipt of their extra earnings on a Saturday night demonstrates that the small as well as the great shareholder has a pecuniary interest in the well-doing of the enterprise; in short, they feel that they are working for themselves, and when that is the case, it requires no necromancy to foretell the result. But the owner also must do his part; he must anticipate breakages and have in reserve duplicates of all the parts where there is the least probability of failure. A good stock of the parts where wear and tear is great, should always be in hand, such as grubber-points, plough-shares, skyfes, porter-wheels, rope-joints, &c.

In our case, although the soil generally is free from stones, the wear of shares per acre is out of all proportion to that which is usual in horse-ploughing; whilst in soils where stones are abundant the expense entailed by breakages, together with the time lost in the repairs, will, with the present form of the tackle, be so great that, in the writer's opinion, it is questionable whether on such soils steam can be economically employed.

With horse-cultivation the traction power being comparatively weak, the pace slow, and the implement light, an obstruction which arrests the plough's progress causes a rebound, but seldom effects much further damage; but with steam the circumstances are very different—the speed is greater, the implement heavier, and instead of a shock being spread equally over all the ploughs or tines, one generally bears the brunt for the whole, so that in a case of collision, while the implement is travelling at its ordinary speed, a fracture of some part or other usually takes place. A break to arrest the motion of the implement when it meets with an obstruction has already been in practical working; but though in some instances this might possibly obviate further disaster, there is little probability of its preventing that which results immediately from the collision, and, where stones or other obstructions to the cultivator's progress exist, it is impossible to effect a perfect cure. We know of only one infallible remedy, that is, "out with them."

The number of shares supplied for the ploughing of the aforesaid 502 acres were 14 dozen, or at the rate of about one share to every three acres. They cost 11s. per dozen, consequently the cost of shares per acre was nearly 4d. The breakage and wear of shares were most excessive when stubbles were cultivated in the end of August and beginning of September, the clay-soil at

that time being baked almost to the consistency of bricks, so that a stone no larger than a man's fist was sufficient to cause a fracture.

The number of skyfes broken for the same acreage was 23, costing 8s. 6d. each, or rather over 4½d. per acre; this is a greater sum than clay soils will, with fair management, generally cost for this item; but in this case the excess was caused by the cultivation of 100 acres lately reclaimed from being a fox-cover, and the roots overlooked in grubbing told heavily on the wear of the skyfes. The mould-boards being steel are durable, and not readily damaged; but on heavy soils, especially when dry and hard-baked in autumn,—so that, as in our case, the tearing up and throwing aside large blocks of baked soil, rather resembles the operation of quarrying,—great pressure is brought upon the mould-boards, and the “stays” frequently give way.

Rope-joints are also subject to frequent breakage, especially where the work is heavy and requires full engine-power.

Stoppages also take place from the anchor being tilted over or dragged out of place, in consequence of the soft or loose condition of the soil through which it travels, or from the wheels meeting with obstructions in the shape of roots or stones which throw them out and prevent their retaining sufficient hold to resist the strain of the engine. In the former case we have found a few turns with a heavy roller along the route to be taken by the anchor to be a perfect cure; but, as prevention is better than cure, when the field is designed for a second ploughing, as for roots or fallow, it will be well to leave a space of 8 or 10 feet wide unploughed by the side of the fence where it is presumed the anchor will travel.

When the anchor does get so much displaced as to require readjustment, the time lost in the operation may vary from half-an-hour to an hour, according as the water-cart horse or any other may be at hand; and this shows how much necessity there is, even in matters of detail, for the farmer's best attention, when the loss of 2s. 6d. or of 5s. may depend on so seemingly trifling an incident.

The rope-porters are liable to get broken by not being removed in time for the passage of the cultivator, and where a hill intervenes between the engine and anchor, the top-sheaves of those porters which are placed on the summit sustain great friction, and are soon cut in two.

But the most expensive of all the items is the wear of the wire-rope. We calculate that this has cost nearly 2s. per acre ploughed. Such is our experience; but in ordinary cases the cost seems to vary from 1s. to 1s. 6d. per acre. On our stiff soil a 12-horse power engine working at 80 lbs. pressure is not equal

to making more than two furrows 10 inches deep. This accounts for the more than ordinary wear of rope per acre, as a two-furrow plough, to accomplish the same work as one working four furrows, will have to make double the number of journeys, and the wear of the rope will consequently be doubled. This estimate refers to Fowler's original tackle with the figure-of-8 arrangement of drum-pulleys. Experience has proved that with his slack-gear and improved clip-drum the wear of the rope is much less. The durability of the rope depends also a good deal on the treatment and the care that is taken of it. When it is at work a sufficient number of porters should be used to prevent it from trailing on the ground, and it is also very essential that they should be kept in a direct line one with another and with the engine and anchor; for if they are placed zigzag, the friction and consequent wear of both rope and porter sheaves are very much increased. Another important matter is to prevent the rope from corroding. At the end of the season, and before it is laid aside for the winter, a coating of a mixture of tar, pitch, and grease should be applied immediately on the completion of the work, and before rust has effected a lodgment. We find that 8 gallons Stockholm tar, 8 lbs. pitch, and 12 lbs. grease is sufficient for 1200 yards of rope. The whole is melted, and kept at a boiling heat over a slow fire of coke, in a cast-iron box having at each end near the top a hole fitted with a moveable roller, through and under which the rope is passed and coiled up as it comes out. A box about 24 inches by 12 inches, and 10 inches deep, will be found of a suitable size. This coating is found completely to prevent rust, and to add to the durability of the rope.

When a rope breaks, it can be spliced in about 20 to 30 minutes; therefore when breakages are frequent, the loss sustained by delay becomes important. It is therefore very false economy to continue to use one so much worn as to be liable to snap at any little extra strain that may be applied to it.

ANNUAL OUTGOINGS AND REPAIRS.

According to Mr. Fowler's price-list the nominal cost of his 12-horse power engine and balance-plough, &c., is 825*l.*; but with water-cart, extras, and other incidental expenses, we believe the actual outlay to be nearer 870*l.*, and we enter it accordingly.

From the able report of the Judges of the Steam Cultivators at the Royal Agricultural Society's Show at Leeds we gather that, in estimating the cost per acre of the work done, they consider 5 per cent. sufficient interest for the capital outlay in the purchase of an engine, &c.; and that 12½ on Fowler's, and 15 per cent. on the apparatus of the other exhibitors, would be sufficient to cover the expense of wear and tear; but, with the

greatest deference to their valuable opinion, we are warranted by experience in concluding that in both items their allowance was decidedly too low. Any one who works a portable steam-engine for 12 or 15 years, at the rate of 200 days per year, will find that if, at the end of that time, its saleable value is not exactly nil, it will only be a short remove from it, so that 5 per cent. is sadly too low a percentage.

Some gentlemen, owners of steam-ploughing tackle, with whom we have discussed this matter, consider that 10 per cent. is not too much to allow; but, at all events, $7\frac{1}{2}$ per cent. is the minimum at which we should put it.

With regard to the $12\frac{1}{2}$ per cent. as equivalent to the cost of repairs, we believe that, taking an average, say of ten years, from 15 to 20 per cent. will be much more likely to be required. At least, this is the conclusion which three years' experience obliges us to come to, and we estimate our outgoings as follows:—

	£.	s.	d.
Interest on the original outlay, 870 <i>l.</i> , less 200 <i>l.</i> on account of the engine being quite one-half the year at sowing and other mill work, 670 <i>l.</i> ; at $7\frac{1}{2}$ per cent.	50	0	0
Annual outlay in new rope	48	0	0
New materials, including shares, skyfes, porter-wheels, anchor-wheels, &c., and general repairs to engine and plough ..	50	0	0
Annual outgoings	148	0	0

For brevity's sake we do not go into the details of the several items, but this sum of 98*l.* for rope and repairs is sufficiently near to the actual average cost for our purpose, and it comes to nearly 15 per cent. on 670*l.*; it must also be borne in mind that this is with an engine and tackle that has been in use for three years only.

The sum of 148*l.* divided by the average number for the year of our ploughing days, which varies between 130 and 140, gives us in the rough a fixed daily charge of 22*s.* From these data, the total daily cost may be calculated as follows:—

Cost per Day and per Acre.

	£.	s.	d.
Interest on capital, repairs, &c., spread over 135 days	1	2	0
Ploughman and engine-driver per day	0	6	0
Anchor and porter lads	0	5	0
Boy and water-cart horse	0	4	0
Coals	0	12	0
Oil	0	1	0
Total daily cost	2	10	0

Or at the rate of 12*s.* 6*d.* per acre ploughed when four acres are accomplished per day.

To compare this with the cost of horse-ploughing we must go back to our statement of the amount which four horses are able to get over per day, which we find to be three-quarters of an acre at a depth of 9 to 10 inches. But this amount cannot be maintained as an average; so that if we assume that an acre costs 20s., we certainly shall not be open to the charge of overstating.

Although our steam cultivation was all deep work, yet as a portion of it was stirring in the spring the land which had been previously ploughed in the autumn, and might be classed as three-horse work, we believe we put it very fairly when we assume that the average cost of the whole with horses might have been over, but most certainly would not have been under, 17s. per acre.

This statement shows a difference in favour of steam of 4s. 6d. per acre, effecting a saving of 112l. on the 500 acres cultivated; and allowing, as we believe we have done, a fair interest on capital invested, with the actual cost of material, repairs, and labour, we really and truly believe this to be the *bonâ fide* result. At all events, we give the facts on which our conclusions are based, so that indifferent persons may readily determine whether they are fairly drawn.

PERCOLATION OF WATER.

The question "Has a more rapid escape of surface-water been observed on strong soils?" as put to the competitors for this prize, is one of the first importance to cultivators of impervious soils, who are exposed to much loss when water stagnates or escapes by surface-overflow. Such influences are highly prejudicial to the crop, not only when the plant is destroyed, but when the temperature of the soil is so lowered as to retard vegetation. They also frustrate Nature's beneficent attempt to restore to the soil by filtration the ammonia contained in rain-water, and, by sealing the pores, they lock up the mineral treasures with which clay soils are so richly stored, which, by the free access of air, with other atmospheric influences, would be rendered soluble and available for the food of plants.

The effect produced by the cultivation of clay soils with horses is in great measure the very opposite of this aim, the necessary conditions either not having been fulfilled, or else rendered inoperative; in fact, if the design was to render the subsoil as impervious as possible, what better plan could be devised than to pound it well, when in a soft, waxy condition, with the feet of four or five horses traversing in a continuous line every space of 8 or 10 inches in width? Indeed, the uninitiated stranger might fancy that the pounding process was the main object to be accomplished, and the skimming off of the puny furrow only an accident or means to such an end.

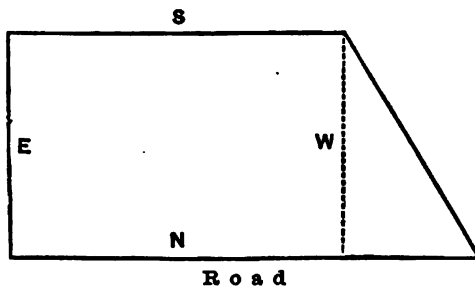
There can be no doubt but that such cultivation is as irrational as it is expensive, and that steam is most anxiously looked to as a power which, in theory at least, offers a satisfactory solution of the question. With the traction-power stationary, or at least confined to the headland, the poaching and pounding of the soil is almost entirely avoided; the ploughs also, instead of sliding along with their whole weight, forming a sole or pan, hard, glazed, and impervious, are supported by wheels; while the consolidation caused by the pressure of those weight-carrying wheels is erased and obliterated by a grubbing-tine which follows behind.

What, then, is the result of the combination of these favourable circumstances? It would be an easy matter summarily to dispose of this question by expressing a general opinion that the porosity of the soil is much improved by the process; but with whatever good faith such a general declaration might be made, still in the absence of comparative facts, its value practically would be but small, because men of different temperaments, enthusiastic or otherwise, might give widely different colouring to the same set of circumstances.

We have had several opportunities of making side by side comparisons of the effects of cultivation by horse and steam power on the percolating powers of the soil, when other conditions were in every respect the same, and the result has been that the evidence in favour of the latter was in every instance unmistakeable.

The first remarkable case which came under our notice was in the autumn of 1860, in a field very stiff and naturally impervious in soil and subsoil, which, having been deeply drained during the previous winter, was cultivated and sown with turnips in the course of the summer.

The field was in a trapezoidal form, as shown in the margin, with a road running along one side of it, on which the engine travelled while engaged in the cultivation. The eastern boundary fence lay in a line nearly perpen-



dicular to the road, and formed a good starting-point for the steam-cultivator. When the spot indicated by the dotted line was reached, we had the alternative of either wasting time by working the steam-plough in short and decreasing lengths, or, as was done, leaving the remainder to be ploughed with horses.

The corner, about two acres, was cultivated entirely with horse-power, and sown at the same time as the rest of the field.

During the autumn months the difference of the absorptive and transmissive properties of the soil of the two pieces was first observable. Within twenty-four hours after any amount of rain fell no stagnant water could be seen on the surface of the steam-cultivated piece, while on the adjacent corner it remained for more than twice that time.

In January, 1861, the roots were consumed on the land with sheep, and the field ploughed from the road in the same direction as before, the corner piece being again cultivated with horses. Between the time of ploughing and sowing a heavy fall of rain occurred, followed by dropping weather, which so retarded the sowing that on the steamed piece a seed-bed could not be obtained until the first week in April. At this time the contrast between the two portions was very remarkable, and spoke volumes in favour of steam. Even then the one part was not so dry as could have been wished, yet the seed went in in fair order; while the other was so thoroughly saturated with wet as to be perfectly untouchable, and, from the month proving wet, it remained in this state until the beginning of May, when it was sown, being even then not in a very dry condition.*

In another piece of 30 acres, adjoining the above, and similar in quality of soil and subsoil, we had in the spring of 1862 another convincing proof of the efficacy of steam-cultivation in promoting the escape of surface-water by filtration.

The field was in roots, and fed off with sheep in the course of the winter months; in February one-half was ploughed by horses and the other by steam. Oat-sowing was commenced in the second week of April on one side of the steam-ploughed portion, the drill working in the line of ploughing until it reached the beginning of the horsework, which was found to be so wet that it was necessarily stopped, and a full week elapsed before that part was as dry and in as good a working condition as the other.

If necessary, and if space permitted, we could quote other instances which, by direct comparison, have enabled us to arrive at a thorough conviction that steam, judiciously handled, will prove a grand and effective agent in increasing the porosity of impervious clay soils. To show that our practice accords with precept, we may mention that in the late season 80 acres of

* To show that this arose from the mode of culture and not from any difference in the texture of the soil, we may mention that the diagonal hedgerow which stood in the way, was grubbed in the autumn of 1861, and this and the adjacent field together ploughed deeply by steam, and that no appreciable difference in the drainage has since been observable.

wheat have been sown under our direction on the aforesaid impervious soils, after steam-cultivation, and although the high ridges are now nearly levelled, only 15 acres of the whole area is water-furrowed, and that at *thirty yards* apart. In no instance during the rains of the late winter has there been any apparent necessity for these furrows nor any appearance of surface-water stagnating, while the soil is firm and dry under foot, and the wheat-plants look extremely vigorous and healthy.

TEXTURE OF SOIL.

To the inquiry, "Has a deeper and more perfect tilth been obtained?" we have no hesitation in replying in the affirmative; for whether the implement used be a plough, digger, grubber, or "smasher," or the mode of applying it be roundabout or by direct traction, if steam be the motive power, a deeper tilth, a better tilth, and a much more perfect comminution of the soil is obtained than could possibly be got by the use of horses.

Who will doubt this who has witnessed the action of a Fowler's plough, fitted with digging breasts or Cotgreave's subsoiling tines, tearing and throwing up the soil loosely and roughly, and leaving it in the best possible condition for a winter fallow? or again, a Smith's scarifier, smashing up a foul clover-layer when so dry and hard-baked as utterly to defy the best efforts of man and his strongest horse-team, but yet leaving the soil, when so broken up, in such a condition that the first fall of rain will reduce it to a tilth more beautiful by far than could ever be obtained by the most assiduous application of artificial power? By Fowler's digger, so deep and perfect is the tilth obtained, and so loose and open does our deep 10-inch autumn work lie, that to ride a horse over it is a matter of some difficulty, and to give him his head over one of our 500 yards lengths would exhaust the energy of the most fiery animal. The foxhunters have found this out, and we have now no fear of poaching by their horses' feet, as the most ardent of these gentlemen will pause before venturing a second time across one of our 60-acre steam-ploughed fields.

When preparing a clover-stubble for wheat, we prefer to the scarifier the plough with common mouldboards, which ensures a perfect turning over of the furrow, a matter of some consequence, unless scarifying can be done while the sun is powerful enough to destroy vegetation. From the speed at which the implement travels it so shakes and shatters the furrow, that we consider land steam-ploughed when dry to be as good as half-harrowed. Indeed, we estimate the results of one ploughing to be equal to a ploughing and dragging with horse-

power, so that even were the expense of each operation the same, the gain would still be much on the side of steam.

INCREASE OF PRODUCE.

“Has the produce been increased?”—In this inquiry centres the gist and pith of the whole matter.

What the result has been on soils of light and sandy texture, experience does not enable us to say, but by some it is considered somewhat doubtful, and at all events this may yet be considered an open question; but on strong soils, as surely as cultivation by steam is more economical than by horses,—as surely as its use increases porosity and promotes percolation,—as surely as it better comminutes and deepens at will the staple of the soil,—so surely does the final result tend to the production of better crops, and consequently to greater profits.

Among the many instances which we could adduce in substantiation of these remarks, we will first notice the difference of the oat crops in the field before referred to, where the greater portion was steam cultivated, but two acres were ploughed with horses. On the first-mentioned piece the crop was a fair one, averaging about 7 qrs. per acre, while on the two acres it was very bad; and though we cannot give the exact yield, we may safely state it to have been under 4 qrs. per acre.

This wide difference can be attributed solely to the different modes of cultivation. Had the whole piece been horse-ploughed, the probability is, that the time of sowing would have been in keeping, and the crop commensurate with that of the two acres. The difference in money-value, at the most moderate estimate, was certainly over 3*l.* per acre, which, multiplied by 17, the number of acres in the piece, amounts to a sum which would cover a great many incidental expenses, which in the imaginations of some are the great bugbear and constant concomitants of the steam-plough. Of course this occurred under peculiar circumstances. Had the spring been dry instead of wet, we should not have expected so great a difference.

The difference in the yield of the pieces stated to have been sown with oats in 1861, at a week's interval, was not so great, but still sufficiently obvious to be noticed by very casual observers, about 1 qr. per acre being the estimated difference. Other comparative instances in favour of steam we could relate, but perhaps a brief account of the general results attending its adoption on the aforesaid impervious soil may be as apropos and interesting.

The geological formation of this soil has already been mentioned; and the land, previous to the introduction of steam-culti-

vation, was let at an average rental of a little under 12s. per acre.

A portion had been shallow drained in the furrows, but previous to the employment of steam, the whole was closely drained 4 feet deep.

Owing to its stiff, tenacious character, the growth of root-crops was hardly ever attempted, and a signal failure was very generally predicted by the local authorities on it becoming known that under the new régime roots were to be extensively cultivated.

In the district annual prizes are offered through the local society for the best swede and mangold crops, competition being restricted to a radius of ten miles round; and notwithstanding the many unfavourable anticipations, the first crop of swedes grown was so superior, that the *first prize* was awarded to it; and in weight it exceeded the second prize crop by 8 tons per acre.

In the following year the first prize for mangold was awarded to a crop grown on this clay soil, and last year, 1862, the first prize crops of *both swedes and mangolds were grown here*.

A corn crop is supposed to take care of itself—at least no one ever hears of a prize offered for the encouragement of the growth of large crops of corn—consequently we are unable to ascertain how we stand in this respect in comparison with our neighbours. We will, however, state the result of steam cultivation on a field in which the former tenant declared himself unable to grow a satisfactory crop of corn, either blight, mildew, or some other disaster, always coming between him and his fair hopes. At the expiration of his tenancy it was very foul, and was summer-fallowed before sowing of the wheat crop. The cultivation comprised a first ploughing with the mould-boards on, while in the second and third operations of cross cultivation they were removed, and the soil scarified only, being thoroughly moved but not turned over. A good dressing of farm-yard dung was applied, and covered in by a furrow from the steam-plough, and not a single water-furrow was drawn in the whole field. In September four acres were planted with Hallett's "pedigree" wheat, at the rate of *six pints* per acre, and the remainder drilled with 7 pecks per acre of the "rough chaff" white wheat. The whole field grew vigorously, and showed no signs of blight or any other ailment, and the yield of the Hallett wheat was 5 qrs. 3 bush. per acre, weighing 60 lbs. per bushel; and that of the other variety 5 qrs. per acre, weighing 63 lbs. per bushel.

During the late year, 1862, about 130 acres of wheat were grown here, and enough is now thrashed out to prove that the average yield of the whole has been quite 4 qrs. of good wheat per acre. When the poor condition of the soil, shown by the aforementioned low rent, is taken into account, together with the

circumstance of a considerable proportion being sown in spring after root crops, we think the fact speaks well for the prospect of profits from the adoption of steam culture.

We do not, of course, *entirely* attribute the decided success of the root culture and the increased produce of grain to this agency. We believe that without thorough drainage such results would not have been achieved; but it is certain that, even with drainage, minus the steam plough, they would have been equally unattainable.

In conclusion, we have no doubt as to the beneficial results arising from the application of steam to the cultivation of *strong soils*. The great object now is to simplify and perfect the apparatus and its mode of working; to reduce the tendency to breakages, and thereby increase its capacity for work. Confessedly these breakages are the weak point of the system, and when obstructions exist in the soil, they are difficult to avoid. But, as has been already pointed out, much of the inconvenience and loss arising from them may be avoided by keeping in stock duplicates of all parts subject to breakage, and by a rigid attention to matters of detail.

The system, however, is yet in its infancy and capable of further development. The ingenuity of the manufacturer is still ever on the watch to perfect his machinery, and we will not form so poor an estimate of the talent and enterprise of our modern agricultural machinist as to doubt the speedy accomplishment of very material improvements.

Yet the foundation has already been so surely laid, that in the mean time we would say to all engaged in the cultivation of a sufficient extent of *strong impervious soils*, who have the option, invest at once in tried implements already provided, and change the horse that must eat whether he works or not, for one whose consumption of food is limited to the hours of labour.

Buscot, near Faringdon.

XXI.—*The Breeding of Hunters and Roadsters.*

By J. GAMGEE, SENIOR.

PRIZE ESSAY.

THE subject to be treated of in this Essay is one which will undoubtedly repay the agriculturist for any amount of attention and skill which he may devote to it.

In aiming to produce a horse of that stamp which will realise the highest price for hunting purposes, the breeder is on the safest way to exclude the chances of failure; because the animal

which just misses the character of the first-class hunter is of a quality which is available for the greatest variety of purposes, either for saddle or harness, or for recruiting the military dépôts of the nation with the horses best suited for the service.

The subject requires to be considered in its economical as well as in its scientific and practical aspects. No amount of foresight will enable the breeder of hunters to obtain his highest aim with more than a fair proportion of his produce. In order, therefore, that a profit may be realised, the average horse must pay its expenses; those of a superior quality will then leave a good surplus gain, of which part will be required to cover deficiencies arising in a few inferior lots. This law of compensation applies to the breeding of horses of all classes; but its range becomes more extended as the stock rises in the scale of value; so that in breeding for the Turf, where the real prizes, when secured, run very high, the failures—weeds, as they are called—are most numerous and most unremunerative. Therefore, the more generally useful the class of horse is which the breeder aims to produce, the less will be his risk, and the greater the probability of profit if proper means are employed. When breeding is conducted on this principle, the type or model specially sought after is that of the noble weight-carrying hunter.

To define what is understood by the term *hunter*, it is necessary to go somewhat at large into the character of English horses, the different breeds or classes into which they are divided, and also into the history and progress of the race. The hunter has at no time constituted a distinct breed; in that respect he differs essentially from the pure blood-horse, whose genealogy has alone obtained a reliable record. The long-established renown of the English and Irish hunter has depended and must depend on the judicious crossing of breeds, with equally judicious management in their rearing, as well as on the judicious development of the breeds thus blended together. That some thoroughbred horses make clever, nay, the best, of hunters, does not alter the proposition just laid down, because they form exceptional specimens.

The hunter is required to possess power, speed, and endurance in combination, to fit him for the stiff country he may have to cross; and for the high weight he will have to carry; but few thoroughbred horses can be found capable of fulfilling these requirements, and still fewer of these are generally available for the purpose, since the turf and the stud monopolise such choice specimens. If there be some gentlemen who, having no predilection for the turf or for breeding, prize good hunters so highly that they secure a few thoroughbred colts of the highest stamp for this object, still

this source of supply is limited, uncertain, very costly, and prejudicial to the public interests.

If the whole number of blood-stock bred in England, in any given year, were looked over when yearlings by good judges, less than 10 per cent. of them would probably be pronounced likely to make hunters able to carry 14 stone; and if it were possible that a few of the most powerful of these could be secured for the purpose and converted into geldings, as in most cases would be necessary, our supply of hunters would be but little extended, whilst the process would sap the very foundation of our breeding establishments.

If only ten of the best-looking stout yearlings were annually picked out, amongst them would be comprised those of the 'Stockwell' and 'Voltigeur' class, and thus the standard of the horses to which breeders must turn for purity and stoutness would at once be lowered. All such exceptionally good horses as are here contemplated, whether bred or bought, would cost the owner probably 1000*l.* apiece before they reached the age, or had passed through the changes and ordeals necessary to make the hunter. Although the training-stable may readily mount the light-weights, or even furnish brilliant chargers for the army, it is only by forethought and good management applied to cross-breeding that men of heavy weight can be adequately supplied with hunters. Size, substance, and power, with sufficient speed, may thus be secured, whilst in symmetry nothing, perhaps, may be wanting.

The history of the English hunter goes farther back than that of fox-hunting. The various accounts given of the Roman conquest of Britain inform us, that even then, England furnished good horses, and that, some 1500 years before we have any authentic record of the importation of Eastern blood for the improvement of the native breed. We have had, then, an old English race of horses, the history of which is lost in the distance of time; and from that stock, no doubt, the stamina and peculiar character of the English hunter of all times has been in a great measure derived. Moreover, if we take into account the fact that the natives of Britain have always been skilled in and pre-eminently fond of the chase, we may reasonably infer that they cherished and prized horses suited for that purpose when hunting was a national service no less than a sport and pastime.

It may be true that men in our own time take to themselves too exclusively the credit of attention to improvements in horse-breeding. The answers which History, when impartially studied, gives to our inquiries, often tell two ways, and with a benefit received, exhibits an attendant drawback. When the land is placed under cultivation, and the animals that feed on it are

brought under the control of man, their condition is improved or made worse, according as the artificial system has been well carried out,—that is, with the consciousness that every infringement on Nature's laws by man calls for compensating art and labour to devise and supply means which may counteract the evils arising therefrom,—or the reverse has been the case.

When people, taking a contracted view, contrast the English horse of the present day with the poor, rough, uncared-for creature they imagine he must have been in ancient times; they support their argument by reference to the little animals still found in some parts of the kingdom, the New Foresters, the ponies of Wales, and of the Shetland Isles. But in this they totally overlook the influence which a great change in their destiny has exerted. Unlike the larger and nobler horse, when he was free, the modern forester and mountain pony has been driven from the fertile plain, and doomed to live on sandy and boggy wastes or to share with the goat, the deer, and little sheep the scanty vegetation of the mountain. Though such has been their lot for centuries, yet how perfect the form of many of them! how sound their constitutions and limbs! and how wonderfully their size has become adapted to their subsistence on scanty provender, whilst exposed to all kinds of weather!

The climate, soil, and topography of Britain were, it is reasonable to believe, as peculiarly congenial to the horse in early as they are known to be in modern times; hence the superiority of English horses over those of most other countries. With extensive tracts of natural pasturage, large forests, mountain and dale alternating, the horses of olden time found abundance of food, with shelter and shade to afford protection in all seasons. Horses so situated, we know, migrate in numbers together from mountain to valley, and *vice versa*, as the seasons change and as the requirements of food and variations of temperature prompt their instincts.

The old stock of English horses must have received periodical additions, at various epochs, in ancient times, from Continental nations. We are especially informed that some four thousand cavalry constituted part of the army with which Julius Cæsar invaded Britain; and the Norman and other invaders, besides the Romans, naturally brought their horses with them. Under the influences of a soil and climate congenial to his nature, it may be inferred that the imported horse improved by the change, and that fresh importations of stock wrought progressive changes in the whole race, and from these combined influences the characteristic stoutness and other special qualities of the English horse were established.

We have, however, to search far down the history of time

before we find any distinct record of the importations of horses from the Eastern nations and the south of Europe. Early in the 17th century, King James I. bought of Mr. Markham an Arabian horse, imported from the East by the latter. This horse is reported to have been the first of that breed ever seen in England; but it would be hard to establish the truth of this assertion. Since Britain long continued to be a dependency of Rome, herself the mistress of the whole civilized world, so that lines of communication were constantly open from east to west, and especially traversed by the armies of the Empire, is it not probable that Roman officers availed themselves of opportunities of possessing Eastern horses, and that some of these accompanied them into the far West? To show that the English horse was of no mean character, when the Arabian above alluded to was brought over, I will quote the authority of one who was generally reputed the best judge of horses of that time. The Duke of Newcastle, speaking from his own knowledge, "describes the Arabian which was imported and sold by Mr. Markham to the King to have been of a bay colour, a little horse, and no rarity of shape." (*Beranger*.) The value to be attached to the above quotation is the evidence it affords of the relative high standard of the English horse of the time.

In devising means to establish the best possible stamp of hunters, our wisest course is to take systematically into consideration the prevailing defects in the breeding of the several distinct classes of horses from which the supply is derived, more especially those classes whence the most powerful and active mares should come. Disregard for the equilibrium to be kept up amongst these several classes has been a potent cause of the falling-off in the number of good hunters of late years. During the progress of descent through successive generations there are always agencies in operation which tend to make horses become lighter and lose stamina, unless rational management keeps the stock strong and pure. Simple neglect produces deterioration, especially if it leads to the use of a bad stallion. Bad blood-horses have been too much used, and mares of their stock too often retained to supply the places of their dams and grandams, while the sale of the latter has often proved a permanent loss both to the breeder and to the district to which they belong. With the increased demand for exportation of the finest mares, the difficulty increases of supplying their places, and even producing stallions of their class; indeed, the course of events leads rather to total dispersion than to mere deterioration or numerical scarcity. Though I submit that good blood-stallions are alone reliable for the production of hunters, and that the mares should also be closely up to the required standard for speed, and whilst

power and stamina should form the leading features in their character, I am in no way inclined to dogmatise on the exact amount of pure blood which affords the best promise of combining all the essentials in the clever hunter.

The meaning which the words "half-bred" and "three parts bred" commonly convey, whether used technically or literally, is most inexact and vague. We may instance "The Lawyer," a horse still in training, which has proved himself to be one amongst the very best horses of his year; yet he is called a half-bred horse, though he has descended from the choicest of blood-sires for six or more generations, and on the dam's side to the remotest point to which the pedigree can be traced. The first ancestress named is the renowned "Jenny Horner," considered the best cocktail of her time, and that some sixty or seventy years ago. It would seem that Sir Tatton Sykes bred from "Jenny Horner's" descendants, and at an earlier period used them as hunters. The question is thus opened whether some of the most promising amongst the intermediate line of produce might not have proved successful racers, as it was only through the accident of his being trained that "The Lawyer" was found out to be the speedy animal he is.

I believe that to place horse-breeding on a secure basis the pedigrees of more than one recognised class should be kept for public reference, in the same way as the General Stud-Book has been for the blood-horse during more than a century and a half. The word "difficulty" stands in the way of all new measures; but the way to set about establishing such a register was never so plain as now. The Royal Agricultural Society of England, the Royal Highland Agricultural Society of Scotland, and an analogous Institution in Ireland could together accomplish more good in the direction indicated, within a few years, than could formerly have been effected in a much greater length of time by a long series of trials.

The example set in the establishing of herd-books, and registrations of the produce of greyhounds and other dogs, encourages me to think that the difficulty in the more important case of the horse is more imaginary than real. Indeed, the longer period during which the horse lives and continues to propagate, and the relative slowness with which changes are effected in the race, render registration in their case more easy as well as more imperative. If the question be raised, how shall we get a satisfactory starting-point? our past history will give the best answer.

The important step taken under the auspices of, and by command of Charles II., in the 17th century, with reference

to the blood-horse, might have been deferred indefinitely, had not the scruples, which in every similar case present themselves, been overcome. At that time a commission was issued to select and collect a number of the purest mares and stallions of oriental descent that could be found. These formed what was called the Royal stud, the nucleus from which sprang the far-famed English blood-horse. The wisdom of this measure has never been questioned, neither has the way of its execution.

The original blood-horses evidently did not all come from one particular stock. Damascus and Aleppo supplied some; but, apart from traditional history, we can still trace in the stock of the present day some specialities in the character of the different lines which indicate a distinctive origin. Blacklock and his progeny stand in remarkable contrast to Whalebone and his, exhibiting the special characteristics of their ancestors, whether they be traced back to Highflyer and Herod, as the representatives of the stronger outline, or to Eclipse as the representative of the finer Arabian cast. Yet the finer shades of difference which the subsequent intermixture of stock of different qualities has produced, exceed our powers of discrimination.

The position of our colonies may afford us a useful illustration of the manner in which a register for any breed of horses may be started. Such colonies as Canada, Australia, New Zealand, the Cape, &c., are in many respects as well adapted to the horse as the mother country. It is as important for these States, as for ourselves, that horse-breeding should go on systematically, and not be left to chance. They have, therefore, strong inducements to form a register; but their own peculiar uses, predilections, and climates, will determine the character of that register, as well as that of their purchases and general management. It seems just as easy for any of these to begin with two or more Clydesdale mares and stallions, certified as of pure caste; by the Highland Society's judges, as to begin with blood-mares and stallions, vouched for by the stud-book; in both cases a new register begins; and if, instead of these two classes, Yorkshiremen should take their Clevelands, the Norfolk farmer his trotter, the Suffolk man his punch, and the Irishman his hunter, it is not apparent why these several classes could not be kept pure, and crosses afterwards carried on with a knowledge of what was being done, and consequently a more correct anticipation of the result. If this could be done in the colonies, there can be no valid reason urged why it cannot be effected in this kingdom.

Greater changes have been made in the breeding and management of horses in England during the last fifty years than in any similar period on record; but these have not rested on any sound

basis. Horse-dealers' suggestions, capricious demands which temporarily influenced the market, have led men to alter their conduct with as little consideration as they changed their vests.

Few good judges, and especially among those who can remember longest, see reason for congratulation on comparing the present with the past, particularly with reference to the hunter, and the high class hack, and carriage-horse.

Meanwhile in those animals which propagate and therefore multiply more rapidly, such as dogs, pigs, fowls, and even sheep, great changes have been effected by individual enterprise in a few years; whilst the horse, the favourite of princes and nobles, appears to require to be specially fostered by the patronage of the great, or by union and concert among the many.

Hunters have usually been identified with the country in which they are bred. We pronounce a horse to be of Yorkshire, Shropshire, Norfolk, or Irish breed, from his characteristic form; but these have had in the main a common origin, represented in the blood-horse; though the influence of soil and culture together, in great measure, fixes their character and decides their worth.

Too much stress cannot be laid upon the judicious management of mares and foals: with care useful horses may be reared from indifferent stock; whilst without it, the produce, though well descended, will not be worth their cost. In feeding young stock, extremes should be guarded against; liberal keep, on sound grass, with corn and hay in moderation, proves the most economical in the end. If more food be given than the system can assimilate, superfluous bulk will be produced at the expense of strength and stamina, and the digestive system will be deranged.

The same rule applies to exercise, shelter, and warmth; for the first, space and liberty are essential, and as regards temperature, it is neither practicable nor desirable for horses that it should be constantly equal. Wet and cold, however, are un congenial to horses, which should be provided with means for at least voluntary shelter.

If horses be properly fed, are protected from rain, and have a dry surface under foot, with space for voluntary exercise, the temperature of an ordinary winter is salutary to them. The horse's coat, then, with the secretion going on over the surface of his body, equalises and regulates the bodily heat. Horses in a roomy paddock do not suffer from a shower in summer any more than schoolboys in a cricket-field; but long exposure to rain in a confined space is injurious to them.

The question of blood *versus* bone is so often raised without receiving any satisfactory solution, that I am induced to make a few remarks on it.

The practice of cross-breeding is constantly resorted to by

farmers, sporting and amateur breeders of various animals, all of whom have evidence to show that they can produce certain desirable qualities in the offspring which neither of the parents possessed. The mule may be referred to as a case in point: here we find the produce much superior in size, power, and action, to the ass; whilst its continuous powers of endurance under exposure to weather and privations, exceed those of the class of horse to which his dam belonged; this superiority is in part traceable to differences in physical conformation, and in part to the temperament resulting from a combination of races. In this case, however, nature has, as is well known, set a boundary to modifications of race, which protects the noble horse from becoming an utter mongrel.

Breeders of dogs obtain, even in the first cross, courage and larger size for hunting and other uses without the sacrifice of reliable exactness; those breeders, however, who succeed best, are most careful to select from types of the purest blood on either side, and without the English bull-dog, the means of producing many of the most useful specimens combining high courage and great strength with other requisites, would be wanting.

Since different classes of English horses varying in height, form, and power, are available for breeding hunters, these can be more readily brought to any standard desired than any particular race, even the blood-horse; power, speed, and bottom, are the first requisites in the hunter, in whom, if the first two qualities are combined, the last or staying power usually results as a consequence.

The height best suited for the hunter required to carry a given weight, is a point on which turf statistics throw but little light. The Derby is sometimes won by a horse more than 16 hands high, and a little less frequently by one under 15, but in the majority of cases by horses which measure between 15 hands 2 inches and 16 hands; so that 15 hands 3 inches may fairly be laid down as the nearest standard height of the blood-horse; and within an inch under or over that standard will be found eight-tenths of the best race-horses and blood-stallions in England.

An attempt to produce horses of any given class much above its normal standard, will, with few exceptions, be realised at the expense of symmetry, action, and power, the latter being dependent on form. Where great power is required, and some of the speed of the race-horse can be dispensed with, the well-chosen blood-stallion may be put to a stout, well-formed, well-bred hunting mare, with a probability of the best result.

One of the greatest errors that has been made in the employment of thorough-bred stallions for country mares has been the

preference given to the largest horses exhibited, particularly if these spurious monsters had a pedigree going back to "Eclipse" or "Childers." As a rule, the overgrown thorough-bred stallion, i.e., those of about 16 hands 2 inches, have done harm in the counties where they have travelled.

When the powerful half-bred mare breeds to the blood-horse, there is always a disposition in the produce to increase in height and length. Some of the largest, ill-formed, and least useful horses have been the produce of bad, overgrown blood-horses, and Yorkshire mares; the stock often exceeding 17 hands in height. On the other hand, the old Cleveland horse, on short-looking legs (short because of his deep and wide frame), measures, when of the best form, about 16 hands; and from mares of that stamp, and a good blood-horse of 15 hands 2 inches, it is easy to produce in the second or third generation hunters which could carry 18 stone over a heavy country, and jump double fences, despite the ground and weight. Though the present requirements of Leicestershire can hardly be met by one or two crosses of blood, still it is important to know how size with good form may be had when wanted.

In selecting a mare to breed hunters, form is usually more regarded than pedigree; not that knowledge of descent is unimportant, but, because with all but blood-horses, it is commonly so very hard to go far back—nay it is good policy, when doubt arises, to stop inquiry, *lest more than the truth should be heard.*

Young mares should be selected in preference to aged and hard-wrought animals; the latter being uncertain till tried. Exception, however, should be made in favour of a mare of ten or twelve years, which had produced some good foals; if sound, she is in her prime. Those destined from the first for breeding, should be put to the horse at three years old, instead of being left barren till a year or two later, as is commonly the case; if they have been well kept, they will be sufficiently developed at that age.

Mares of the stamp for producing hunters are very scarce now, as may be inferred from the small number presented at exhibitions of general stock; yet, with our climate, soil, and national resources, the few good animals still obtainable for breeding would suffice for laying a foundation, if breeders were encouraged to produce and keep stock of the right sort.

The real good half-bred stallion—such as we used to see, with his large clean legs, well-defined knee, hock, and pastern joints, with good head, shoulders, barrel, and hind quarters—is now become scarce; these horses when about 16 hands

high, formed a connecting link between the thorough-bred and the stronger classes: from such sires, mares fit to breed hunters used to be obtained, besides many of the most valuable horses in England for general purposes; of late years whenever such a stallion has made his appearance, it has only been to be favoured with a few mares preparatory to his being exhibited, and then sold to go abroad. To find a really good half-bred stallion of this old stamp, at five years old, has to the writer's knowledge been a rare occurrence during the last ten or fifteen years, even in the first horse-breeding districts of the kingdom.

To do justice to this subject it must be regarded both in its general and particular aspects: individual breeders who seek to promote their own particular interests, cannot be expected to take as broad a view of this question as constituted bodies like the Royal Agricultural Society, which is founded to promote national improvements; yet the breeder who succeeds in producing fine specimens of the class of horses best suited to his locality and requirements, will promote the general good; whilst by classifying and bringing them into notice, the Royal and other Agricultural Societies will do their part.

The breeders of horses are for the most part either wealthy amateurs or tenant farmers; to the latter we must turn for the general supply of every description, the race-horse excepted, though it must be admitted that English horses of the best type owe their state of perfection to royal, noble, and gentlemen amateurs. At the present day the stud belonging to her Majesty forms a model to all breeders; and to royal patronage was due the high perfection to which the English blood-horse attained during the last and previous centuries.

From 1750 to 1764 inclusive, three horses were bred in England, by his Royal Highness the Duke of Cumberland, uncle to King George III., which together did more to advance the value of the English horse, than any set of incidents on record. The horses alluded to, were Marske, King Herod, and Eclipse. If we pass over the first-mentioned horse Marske, because he was the sire of the last—Eclipse—we still have in the other two the elements of an entire reformation in the character of the blood-stock of the kingdom. The sons and daughters of Herod and Eclipse are unexampled for their character and numbers; and through these in parallel lines, we obtained such a stock as no other country has possessed. So effectual has been the patronage of those in a high station, in advancing the improvement of our horses, that whenever we search out the origin of any of our best blood-horses, without which the hunter could

not have attained his special excellence, we find in almost every instance some cherished historical name connected with him as the breeder.

One important point in which the rearing of horses at the present day differs from the practice of the last century, consists in the small paddock and artificial forcing management being substituted for the range of the spacious park, with the necessary adjuncts, until maturity was reached.

Amongst the essential conditions for breeding horses next to that of selection of stock to breed from, is the choice of the land as regards its nature and extent; to this point too little attention has been paid of late, and it has a special importance in the case of hunters, because they require longer time in pasture than others, to complete their growth and consolidate the frame.

When the subject of rearing horses on farms which contain little or no pasture, has been under discussion of late, and the relative cost of a young horse produced *in the farmyard* has incidentally been contrasted with that of one purchased of the same age, it has been argued that the price of the horse bred on the farm is not felt like the payment of all the money in a lump. It is strange that men of the sagacity of farmers should make any such exception to the broad commercial rule of exchange, which never applies more forcibly than in this case.

The first question for a man to ask himself, who has a desire to breed horses, is,—have I the necessary pasture-land for the purpose? Without this nothing can be done in the matter; with it and the necessary capital everything can be accomplished. Good sound old pasture is that which admits of the best hunters being produced with the least help by artificial means; such land as grows the best wheat seems also to suit horses well—the North Riding of Yorkshire may be cited as a case in point. Well-drained land is essential, and a dry surface most favourable,—whilst wet flat lands may grow grasses and feed horses to a large size, hunters can never be produced on any other than good firm soil; if the surface be hilly, all the better; if some of these natural advantages be wanting, yet horses bred on sloping ground, where they have variety of exercise, become finer in form, with better action, than when bred on flat ground.

Many of the best horses known at all times have derived their high qualities from the physical character of the ground on which they were bred; the more extensive and diversified this is, the less risk there is of foals breaking a leg whilst galloping and playing in a confined paddock. I never knew of a similar occurrence where the young animals have had space and inequality of ground, to give them strength, with the will to use it.

With a regular supply of good sound food, horses may be

bred to a very high state of perfection, on dry poor soil; so far it is a question of expense. I have seen horses bred on inhospitable ground, and there left to nature, which, after care has been taken to get them into condition, have become serviceable animals; but a horse bred on swampy ground, or confined in a soft, wet, filthy farmyard, or stable, may grow large and heavy, as they generally do, but can never be good for any purpose. Fine shape, good action, compact textures, with sound constitutions, and feet, such as will bear exertion, are requisites pre-eminently required in the hunter, and no class of horse should be without them, to the highest attainable degree; yet none of the above qualities can be acquired unless foals and growing colts have liberty on firm ground: this proposition is based on some of the fundamental laws of nature which cannot be violated with impunity.

The experience afforded by other nations confirms this view: thus France, having few natural advantages, purchases horses for common use from Germany, and has recourse to England for choice specimens of valuable breeding-stock; Northern and Central Italy obtain their horses from the same sources. Even in England horse-breeding is in great measure confined to some of the more favoured counties, where the best can be reared at the least outlay for artificial means.

On some of the extensive tracts of land which belong to the Roman States, horses may be found under conditions which approximate to their purely wild state; within certain bounds they range and breed as free as the deer of the place, stallions and mares running together, *i.e.*, a stallion is selected for the season and turned loose with a certain number of mares: the market value of young unbroke horses, when so reared, depends greatly on the character of the ground; whilst colts bred on high land will fetch 300 crowns the pair, those reared at the distance only of a few miles on low soft marsh land, will realise only 50 or 60 crowns apiece. Wherever the matter has been tested, I have found that the character of the soil and general management influences the wearing powers of horses more than that of their parentage.

Where attempts have been made on the Continent to breed horses in small enclosed paddocks, such as in England are allotted for blood-stock, without the aid of the English soil, climate, &c., it has always proved a failure: the stock have been high on the leg, narrow, and without form, action, or good qualities of any kind. Where, however, the English stallion is used, and the mares have their native freedom on good ground, relatively good stock has been procured.

Change of ground is good for horses, for the fresh soil and

herbage it presents, as well as for the variety of surface it affords. Land laid down in seeds, though inferior to old pasture, is often serviceable to the farmer as affording an extensive range of fresh ground.

It is not until the second summer that colts require more extent of ground than a small enclosed field affords; the young animals, if they have only an acre of space, will display their speed, by galloping round their dams in a circle. Colts and fillies destined to make hunters, require to have their liberty for three full summers; and it is a question to be settled by the means at hand, whether four summers should not be given. Hunting-colts should be taken up, broken, and be gently ridden at latest during the winter when they are rising four years old: they may then either be turned out again for two months during their fourth summer, or be ridden over the farm at that time, which, with a good rider and proper care, affords the best beginning for a young hunter: such usage is preferable to turning out, though both these courses may be followed in the same summer, to some extent, with good effect.

It is not necessary that the space of ground allotted to mares and foals should furnish all their sustenance during any considerable part of the year; most breeders of hunters, however, will be provided with such good grass-land as will make them independent of much other aid during three or four months of summer. To a great extent the same system that is adopted for the racing-stud may be carried on in breeding hunters; but the practice of running blood-horses at two years old has induced breeders to stimulate their growth and development by free and, I may say, excessive feeding.

To insure the best results, there is only one mode of procedure for different stock as far as the first and second summers, with the intervening winter, go. Whether the colt be entered to run for the greatest early stakes, or destined to carry the heaviest amongst the fastest of riders to hounds, or designed to make a stallion, ample space on good land, shelter and cleanliness, are essentials, without too much pampering; the food to consist of sound meadow hay and oats, to such an amount as the resources of the land, and the state of the animal indicate. Growth, form, and fine fibre, are our requirements in the horse; and it is by giving food of a kind and quantity which can be assimilated that these are produced: any excess in the quantity of food given adds to bulk and weight, at the expense of quality.

Thoroughbred foals and yearlings, under the present method of feeding, eat from 1 peck to $1\frac{1}{2}$ peck of oats per day; and of hay, either cut into chaff or in its normal state, about 7 lbs. The motive for this, as I believe, excessive feeding, is not alone

the prospect of the young stock being put into training at eighteen months old, but especially that of their being previously offered for sale. The object of primary importance, that of producing the most symmetrically formed horse, is thus made subordinate to the desire of turning out the largest yearling colt.

I am of opinion that if the quantity of corn given to some of the blood-stock was diminished to three feeds daily (a change which would induce them to eat a larger proportion of hay), their condition would be thereby improved, even for the time, and more obviously so for the future. What is required in the colt is thorough development of the muscular and nervous system, and of those organs which carry on the functions of nutrition: a little fat will be stored up, according to the natural law; but young horses should never be made up until they are what may well be called "beastly fat." To be liberally fed, so that there is no interruption to growth, their appetites and condition should be carefully watched, and the distribution of food regulated with judgment.

I disapprove of green food, such as vetches, clover, and other grasses, cut when in season, and given in large quantities to horses, of any class. Green forage so given has few of the properties which it possesses when horses eat it off the ground as it grows. In his normal state, the horse selects and masticates, so that the process of feeding is slow. Mown grass becomes first *welted*, then ferments, is stalky or woody, and when placed before horses under restraint, it is eaten voraciously; the stomach and bowels becoming overcharged, digestion is impaired. All grasses should be either eaten off the ground, or else, when cut, made into hay, whereby time is given for the consequent fermentation. When I make any exceptions to this rule, I am very careful as to the kind of grass, and its state when cut—it should be at the point of flowering; and the quantity supplied must be small on the whole, and nicely apportioned between different baits. These statements are meant rather as cautions than fixed rules. In town, the ill effects of giving green food are most marked, because there it is commonly given in an unfit state, through the causes alluded to. The same objections do not apply to roots, amongst which carrots especially form an excellent adjunct to good oats and hay, during a great part of the year, for mares and young stock of different ages. Scientific researches into the chemistry of food have not done much to modify the sound rules of practice long established in England on the feeding of horses. In 1860, the Cleveland Agricultural Society set the example of giving 100*l*. to the best thoroughbred stallion for getting hunters: and the Royal Agricultural Society, by offering a like prize at its three last meetings, with similar conditions attached, has afforded

further scope to the experiment, which has not as yet shown the promise of much fruit. Indeed, there now appear some signs, if not conclusive evidence, to show, that not only no good end is likely to result, but that this large prize tends rather to defeat the object for which it was so liberally set on foot. Without some annexed conditions, no guarantee is afforded that the recipient of the money uses his horse so as to make him available for the breeders of hunters and roadsters. The large prize has either fallen on a horse of high renown, which was serving mares at a fee such as none but breeders for the turf can afford to pay; or else it has been given to a young horse which should have won his way to favour gradually by his merits, and thereon the price for his services is increased to an amount which places him quite beyond the means of breeders of hunters.

Unconditionally as this prize is given, any one of the renowned stallions which covers at from 10*l.* to 50*l.* may be walked to the yard and obtain the prize, thereby deterring the owners of more eligible horses from going to the expense and trouble of bringing them to encounter defeat. The line of distinction drawn between the first prize-horse and his competitors is frequently also too broad; and this leads to discontent and complaint against the decision of the judges. The tendency of this prize, then, seems on the whole to be rather to deter than encourage the keepers of really useful country stallions. Indeed, it may be questioned whether the whole system of awarding prizes to stallions by the local agricultural societies of England for some years past has not tended to exhaust the means for procuring a good horse.

Prizes, when given without restrictive clauses, act as an advertising medium, to such an extent that the prize-horses of one year have very rarely been found in England the next season; and as premiums are usually given at the age of three and four years, the animal has been of little service prior to exhibition and sale: prize-mares go abroad as well as stallions; so there are few good mares to breed stallions from, and still fewer good stallions to get fillies.

It must be acknowledged that the blood-stallion has not been so much affected by these measures as the half-bred horse; whilst in the cart-horse class the system has worked well, inasmuch as there is little demand for them on the Continent; and the Scottish Agricultural Societies, particularly, take care that the horses, according as they obtain first, second, and third prizes, shall be located in such districts as the Society directs; and if the same course had been followed in Yorkshire and other districts in England, our beautiful nag-sires would have been retained for at

least one season after their excellences had been publicly proclaimed.

In judging the classes of hunting and roadster or nag-mares, some more intelligible definition than has generally prevailed is wanted. Yet so closely do these blend one with another that it is difficult to draw a line so as to divide them into even two classes; there should, however, be a clear distinction between the hunting and the thoroughbred mare: the latter, if good, is kept to the paddock, and in a general way never becomes the producer of hunters. Moreover, the same objection applies to the mare as to the high-class blood-stallion; they can be walked into the yard simply to receive the prize; the racing-stud would furnish mares such as the dam of Kettledrum, which would carry off the prize, thereby deterring farmers from producing their best, and, moreover, set a wrong example, stamped by authority, as to the kind of mares which farmers should try to keep.

I may refer to an instance in point as an example; at the East Riding Agricultural Show, held at Bridlington about 1853, I saw the first prize for the mare for breeding hunters awarded to Hygeia, by Physician; that mare had never been out of the racing-stable or the stud. She had bred runners, but nothing like a hunter; and has since been remarkable for becoming the great-grandam of Dundee.

Exhibitions of foals with their dams at local agricultural shows afford encouragement for breeding, and also the first and best means of bringing good stallions into early favourable notice.

There are objections to awarding prizes to gelding-colts at various ages, either as hunters, nags, or carriage-horses: in the first place, the breeder has encouragement enough in the probable price he will realise for a good colt; but a second and more positive objection is, that good colts are so pampered by feeding, and by being kept up in the stable, that they seldom turn out good for much afterwards; and here, again, the open system of giving prizes has led to the colt being taken from place to place; whilst a wise farmer with a really good one would not enter into competition of fat against form, a pampered horse against a well-kept and level-formed one, gradually growing into worth.

Whenever prizes are given for horses, the judges should agree to take into account the use for which that animal is required; and when made as fat as a Christmas ox, horses should be disqualified from competition as much as if they were pronounced unsound by a veterinary surgeon.

The scarcity of good blood-stallions, available for farmers, at

reasonable charges, is proverbial; and yet good horses in no small numbers are produced annually: how these can be obtained as stallions seems to be the question, subordinate only to that of a right understanding of the extent to which they should be employed, and of how to select the good and avoid the bad.

On the rules and regulations of the Jockey Club, from time to time in force, will depend the extent to which good blood-stallions can be obtained, since the temporary failure of our supply is in great measure referable to running our horses at two years old. I distinctly use the word temporary, because I do not believe that any radical or general deterioration has taken place. If two-years-old engagements were carried over to the third year, and the more real tests of power and lasting qualities left to be decided at four, the character of the blood-horse would at once greatly improve, and more would be available for stallions without necessarily more being bred. By such reform the forcing of colts would be checked; indeed, it would be incompatible with success, since protracted accumulation of weight would prove an incumbrance. Under a less hurried management, young stock would acquire as much good form as under the present system before being disposed of, besides the larger proportion of them which would be developed into useful horses, of which many are now destroyed before they have had a chance of showing what is in them.

Modern steeple-chasing has drawn heavily on the supply of blood-horses, adapted for country stallions; that sport, which formerly was intended to be a test for good riders across country, and also of the clever hunter, has to a great extent been the means of calling out the indifferent race-horse to beat the horse really fit to be ridden to hounds. Many good powerful blood-horses have consequently been converted into geldings, which, as stallions, might have begun in the lower ranks and reached the highest.

The next and most considerable draught from racing stock is that carried off by exportation; this affects our means of obtaining stallions to get hunters, because the better class of horses are selected—those that have run, have stood their work, and are of good size, and sound. Amongst these horses which annually leave the country, are some equal to the best of those left behind. It may be excusable to point to some inconveniences (though the remedy is not so readily seen); because until the influences in operation are shown, remedies cannot be instituted. Blood-horses fit for country stallions are from the above causes much higher priced now than formerly, hence the scarcity of them amongst country stallion keepers. Some of the best blood-stallions in England formerly travelled in Yorkshire, serving country mares

at two guineas each, and the owners made a good business by the number of subscriptions obtained; an attempt should be made to open up this channel again. What are called tried stallions are not wanted for this purpose; there are always young blood-horses in various localities, advertised to serve mares at ten guineas each, which do not pay their way; yet these, if properly appreciated in a breeding district, would get plenty of mares. Horses so employed have full as much chance to obtain some blood-mares as if they were kept at more important centres, where those of established repute stay. Brutandorf was serving mares at two guineas each, in the East Riding, when one of his sons, "Physician," was the first young stallion of his day, and another, Hetman Platoff, one of the best horses in training. The owner of Brutandorf did his business well, over a succession of seasons, in the same district; and when the horse was about twenty years old, he was sold to go to Russia, for nearly as many hundreds of pounds.

The wintering of mares and foals calls for little special notice in studs which are well provided with shelter, and paddocks for exercise. Farmers, however, can only adopt such measures as are essential or least inconvenient; and although individually they may have only two or three mares, still on them we are dependent for the greater part of our general supply. In their case the farmyard is commonly made the receptacle for stock indiscriminately, when the field affords neither food nor shelter. There is a commonly prevailing notion that wet about horses' feet and legs is either good or not injurious. Nothing can be further from the truth. Without discussing the relative value of open and covered farmyards, I may state that a wet farmyard is most injurious to horses. A small home-field, with a dry soil, is of the greatest use to turn the young horse-stock into daily. Shedding can be made temporarily in fields distant from home by means of upright posts, across which smaller timber or rough materials may be placed, to be covered with furze, reeds, haulm, and such-like material, and finished off with thatch. Such a shed for mares and foals or young growing colts will be as comfortable and as conducive to their health as the most elaborate building. Care must, however, be taken that the site is dry and free from all accumulations of wet, nor should these animals be allowed to stand upon an accumulation of dung, but their sheds should be as clean and dry as a well-kept stable. Those rules are not less applicable to permanent buildings; firm, clean stone bottoms are the best surfaces for horses to stand on; these should be thinly covered over with clean straw, which should be changed and the floor swept daily.

Breeders of hunters require to be, as they mostly are, good

judges of horses generally, that each animal may be assigned to his proper use. When a colt is growing large and coarse, more like a coach-horse than a hunter, it is well that this should be seen in time, before extra expense is incurred, when perhaps the proper time for sale would be passed over; though good horses often run in families, there is nevertheless frequently great diversity, even in horses that are full brothers.

Hunters of the greatest power, and the best performers under heavy weights are usually about 16 hands high; and some geldings exceeding that height are very well-formed animals, and have good action. Most experienced riders, however, who are in possession of a very good large horse, will be able to tell of one that could carry them quite as well which measured a hand less: my own experience is against high horses; hunters of from 15 to 16 hands high may be equally good for different weights from 11 stone upwards.

Some of the questions which most perplex men in trying to understand the relative merits of horses from their sizes, shapes, and general external appearance, could be reduced to more simple rules, if action were better understood than it has been. Excellent judges of both form and action are to be found who yet, from want of some fundamental rules, are unable to connect the one with the other. Hence the fine form of a horse is not appreciated until after he has performed some feat; and, since the value of the horse turns principally on his locomotive power, the art of breeding and rearing hinges on a right appreciation of action, which is the representation and offspring of form.

When horses like Little Wonder and Daniel O'Rourke, that were sensibly under 15 hands high, are seen to outrun horses of 16 hands for the Derby, it is generally thought that the little horse has gained over the larger, through his quicker movements; that more strides must be taken in the one case than the other; or else that the lower horse keeps up the pace the longest, as is really the case, the larger horse being the weaker. But as regards the length of stride, the notion of the little horse having the shorter is very probably wrong; and when he has beaten the larger animal, it generally is by his length of stride; and the same construction which gives that faculty, confers the power to keep it up.

The eye is the best guide to the forms of the horse. Like the sculptor and painter, we cannot proceed far by measurement; although, like the artists, we can run our rule over one or two points, and then take in the details with the eye.

When making a few remarks on what is understood as good shape in horses of different classes, I will not so much repeat accepted rules as notice a few exceptions to them.

The head of every horse is an important point to be observed

and studied. Mechanically considered, the head, by its form and position in relation to the neck and trunk, regulates the action and powers of the horse. Functionally, as the seat of the senses, the head indicates the general character of the horse; and this is the more important consideration.

Good heads I consider may be found in two forms; firstly, we have the Arab type of head, with its broad forehead, tapering muzzle, capacious nasal cavities, small ears, and large free space for the breathing apparatus to play between the upper vertebræ of the neck, and the broad expanse of the lower jaw. Everybody agrees in considering such a head as most beautiful when it is in keeping with the rest of the horse. This character of head, transmitted down a line of our blood-horses, pervades the breed, and is exhibited to a great extent in our mixed breeds. Nothing tends to stamp the character of cross-bred horses so much as this head, taken in connection with form. It is by no means my object to disparage this caste of head, which is characteristic of the finest Asiatic horses, but simply to remark that the head which becomes one horse or class is not the best for all.

The Barbs generally present a different type: in these we find the horse larger, his hind quarters somewhat drooping (not like the vulgarly-bred horse, but resembling many stout racers), the chest deep, with large fore-quarters and loin; the profile is longer and more flattened, the ear and eye very beautiful, all giving a placid appearance, whilst the head is fully as easily placed in relation to the neck and trunk as that of the Arab just noticed; moreover, the nasal passages are fully as capacious in this class of oriental horse as in the other.

The Barbs formed in all probability the parent stock of fine horses extending over the south of Europe, as their characteristic qualities have always been exhibited in the Andalusian horse, the Calabrian, the choice old breeds of Rome, and those of the island of Sardinia; and their form of head is characteristic of some of the English lines of blood-stock to the present day. When the broad square head is found in common breeds or in the heavier class of horse, it looks dull, as is seen in those of Central Europe, including those of Switzerland and France.

Artists have fallen into the way of always giving the same head to all forms of horse; and the Paris prints always show the uplifted head, with expanded nostril, and out-stretched tail. But our colossal figures of great horses with these square heads are quite out of keeping. That I may not be supposed to admire the large bony head of the horse of Flanders or Normandy, or of some of the English horses, I will point to Voltigeur as the representative of the fine type I approve of.

The point to be looked to in the head of a horse is its connection with the neck so as to admit of its being brought into a graceful position, when the horse is easily broken, moves gracefully, and breathes freely. If a cross-bred horse combines a large square head with a defective connexion in relation to neck and trunk, he cannot bring his forehead into a good posture; and if this be attempted he breathes with difficulty, hence many roasters are found of this form.

Let us, then, improve heads by careful breeding; but not try to obtain on one horse the head which would have better become another.

Whether looking at stallions, mares, or their produce, breeders will be more likely to arrive at a correct appreciation of their worth if they take the whole animal in view at a glance, when, if nothing offend the critical eye, it is most likely that more strict and patient examination into details will confirm the first impression. Men, on the other hand, who are always talking of points, and criticising in detail without knowing what relation one part bears to another in producing such effects as constitute good action, are seldom right by chance.

The choice of a stallion with the idea that something in his shape may correct a defect in the mare is seldom found good in practice; that a horse has good hocks whilst all the rest is indifferent, cannot justify his selection: I have never seen good derived from these compromises; sire and dam should be good all over.

Two measurements may be taken of a horse, which will be found useful and afford instruction, after which the rest may be left to the eye and the touch. Every symmetrically formed horse in good and normal condition will be found to measure about one-fifth more in girth, viz., round the circumference of the chest, than he measures in height; he should be of the same height, when standing on level ground, over the withers and rump.

By this rule a perfectly-formed stallion of 16 hands in height will girth 80 inches, whilst the good Clydesdale of 16 hands 3 inches will fully sustain that proportion; and horses of lower standard show no noticeable difference where we find perfection in form.

When the above proportion subsists, the form of the horse will generally be good. Such form ensures a good loin, and, almost as certainly, the well-placing of the shoulder and the good proportion of the limbs, the form and character of which must be scrutinized to the ground: light, powerful, and easy movements result from proportionate construction.

The paces of the horse, the walk, trot, and gallop are all

brought into use in the hunter and hack, as they are also constantly exercised in turn by the animal when free. Of the two subordinate and more artificial paces, the amble is seldom seen in England, nor does the English horse take to it easily; but the canter is a common requisite, and is a distinct movement, though it has been regarded as a slow gallop, to which, however, it has no real resemblance: the so-called canter in the trainer's language, is a gallop, and no canter at all.

Passing over the important paces of walking and trotting, I have a few words to say on the faster, the gallop.

Under the conviction that those who have attempted to describe the gallop in the horse proceeded by chance, with insufficient knowledge of the laws of progression, I have devoted much time to experimenting on different animals.

The accompanying diagram, taken from my unpublished collection, shows two representations of the gallop. Figure 1 represents the impressions left by the feet of a five-year-old well-bred Irish mare, which measures 15 hands 2 inches high, and is in other respects of good form and action. The mare was galloped over the fresh sands on the sea-beach for the experiment on 30th November, 1861, and this figure shows the prints on the sand and the relative position of the feet when in action.

No. 2 shows a similar measurement, in the instance of a two-year-old racing-colt in training; it was taken, on the 13th January, 1862, on Richmond Moor, when the colt was going at a good gallop.

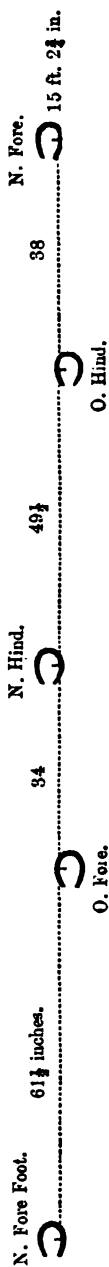
Before I make remarks on the gallop I must say a few words on the descriptions hitherto published.

By all the writers with whom I am acquainted the gallop is described as consisting of a succession of leaps; the horse's feet and limbs are placed in all sorts of positions but the right; whilst the great artists who have understood the subject best, from some motive or other, have generally represented the horse whilst standing still. The subject of proportion and progression has been looked on as settled by Vial de St. Bell, in his *Essay on the Proportions of Eclipse*, published 1795, who exhibited a diagram which is as erroneous as the text which gives the measurements. Passing over other teachers and writers, we come to the late Mr. Perceval,* who gives the views which up to the time he wrote had been published by others. He says (page 150), Mr. Blaine observes, that "as the two fore feet at once beat the ground together, and then the two hinder, so it is evident that the gallop of speed is nothing more than a *repetition of leaps*."

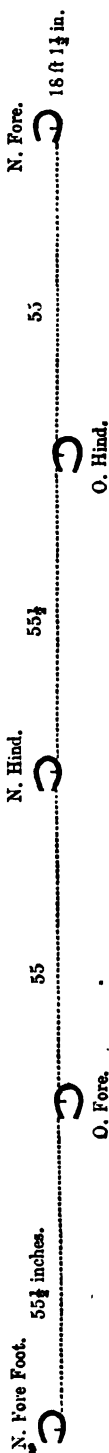
* 'Twelve Lectures on the Form and Action of the Horse,' by William Perceval, M.R.C.S., Veterinary Surgeon to the 1st Life Guards. Longman and Co., London, 1850.

LENGTH OF STRIDES.

I. GALLOP OF IRISH MARE.



II. GALLOP OF RACEHORSE IN TRAINING.



Mons. F. Lecog is also referred to by Percival, as calling the gallop "a succession" of leaps. Mons. Lecog, in the later edition of his elaborate work on 'Progression,' p. 432,* adheres to his previous description.

Neither have these so long prevalent notions been limited to writers on the horse. Naturalists and comparative anatomists have taken for granted, that what was so authoritatively given with illustrations, amplified by elaborately-written pages, was all reliable and sound. The action of the horse has puzzled some of the greatest among human physiologists, the movements of the quadruped being found more complex, when attempts were made to analyse them, than those of man: these difficulties, however, seem all to be based upon a misconception of animal locomotion generally.

Dr. Humphry, in his large work on the human skeleton, published in 1858, follows in the beaten track on the subject of progression; and the professor, in his more recent work, published in 1861,† goes still more at length into the supposed action of the horse, to illustrate that of man, where it is very clear that he is misled by the teaching on the physiology of the horse, and consequently the author's special subject has not profited by the importation.

My two diagrams represent two animals as galloping, with what is called "right leg first;" these figures cannot, however, show movements in the order of sequence: I will therefore explain; and then show how the force is distributed over the four limbs, and how they move in succession.

The horse getting under weigh, which is done with least expense of power in a walk or trot for a few paces, pitches into his gallop more or less rapidly; in doing so the near hind foot is first moved, next the near fore, the off hind and off fore following in sequence, so that the off fore, which in the case is said to be going first, is the last to be raised; if the horse changes his leg the order will be reversed.

It is only in the canter and gallop that the hind foot does move first. The line of gravity, as Borelli states, is kept perfect by the first move in the hind foot: that limb being the first to make a short preparatory move, it next makes the fifth move, following in sequence to the off fore leg, and this is the true order of movement afterwards kept up.

The horse's balance in his gallop is as perfect as when he is

* *Traité de l'Extérieur du Cheval et des principaux Animaux Domestiques.* Par F. Lecog, Directeur de l'École Impériale Vétérinaire de Lyon, &c. 3^{me} édition. Labè, éditeur, Place de l'École de Médecin, Paris, 1856.

† *'The Human Foot and the Human Hand,'* by G. M. Humphry, M.D., F.R.S., Lecturer on Anatomy and Physiology in the University of Cambridge, pp. 66-67.

standing or walking; he is so distributing his power, and the feet moving on the ground are one by one raised, and in the same way and succession implanted. Two feet of the horse are always on the ground in varied positions; whilst of the other two, one is disengaged in the air and the other in the act of alighting or rising. But the horse, the observer will say, gallops by strokes seemingly, using a renewal of efforts, his power is exerted in diagonal lines, thus the action of the near fore and off hind leg moves in close sequence, off fore and near hind following. The sequence of action between each fore foot and its diagonal hind on the ground is so blended, as to make the exertion of one continuous leverage. However we may regard his action, the horse's equilibrium is perfect; the two lateral limbs move in sequence, so that the fore is always carried forward before the hind has passed the centre of gravity. I have hitherto observed the movements, in diagonal and parallel lines; the fore limbs, in each direction, preceding the hind, with the exception of the first move in the gallop and canter, required as a preparatory and balancing move, not amounting to a full stride.

I cannot admit that either the horse in galloping or any other quadruped flies through the air by means of a succession of bounds: all jumpers are slow movers, and the horse loses time by every jump he takes; the faculty of leaping is reserved for a particular purpose, and not employed as a means of fast progression—a little serpent will go twice across a broad road on its belly before a frog will get once over it by jumps.

If by any device a steam-ship could be so constructed that its paddles were made to strike the ocean-waves as the horse's feet are implanted on the ground, with what speed, steadiness, and safety would it advance! If we watch a race where the upper part of the horses and riders are alone in sight, because some obstacle such as a hedge or wall hides the movement of the horse's legs, we shall see directly that the horse does not jump or oscillate, but moves evenly, as a bird flies, or rather as the masts of a steam-ship, when the jerking movement of the machinery is in like manner out of sight. Moreover, the distance at which each foot is implanted from where it was taken up, is no way dependent on mere length of limb, but represents the product of all the motive powers exerted; the velocity at which the body is moving through the air determines the distance of stride.

If the physiology of progression in the horse can be made plain, such knowledge will, by leading to a better appreciation of symmetry, be of the first importance in practice. It will be recognised from the tenor of this essay that height and long legs do not necessarily give long stride; and we may come to under-

stand how it was that Daniel O'Rourke and Little Wonder, when under 15 hands high, beat for the Derby in their respective years good competitors which were a hand higher than themselves. We shall further see how it is that a little animal like the fox is able to run for two hours before animals similarly constituted and much larger. The same law is in operation in one case as in the other.

I will conclude with a few remarks about the feet of young horses of different ages before being put to work. If two pieces of advice which I have given be carried out, the feet will not require much art; if the stock can have plenty of space the friction caused by exercise will keep the hoof in proper form, and the inner structure will by the same influence be duly developed. Besides this, if horses when brought under cover, stand on a dry hard bottom, the feet will acquire form and strength. Periodical visitations, if to wash and clean the feet, should by all means be adopted; though, if the frogs are free from thrushes, there is no necessity for operating on the feet. Paring the feet I do not think advisable. Once or twice in the winter if the colts cannot get room out of doors, a blunt old rasp may be taken to equalize the plantar surface of the feet, and a little lowering of the outside may be necessary, especially with narrow-chested colts. The greater wearing down of the inside is apt to twist the foot and pastern, and even tends to turn the elbow in. Whenever mares or foals are deranged in health, a veterinary surgeon should be called in early, as nothing prescribed by anticipation is likely to meet the requirement.

New Veterinary College, Edinburgh.

XXII.—*Five Years' Progress of Steam Cultivation.* By JOHN ALGERNON CLARKE.

IN the twentieth volume of this Journal it was my good fortune to chronicle the successes of the steam-plough to the close of the year 1858. I have now to present a summary of mechanical improvements and practical results which since then have made steam tillage the pre-eminent triumph of modern English agriculture.

Not that certain sanguine expectations have become even approximately realized. Analogy from the achievements of the steam-engine in the factory gave but fallacious promise as to its performances in the field. One pair of hands, with steam-power and a spinning-machine, might draw out and twist up a thousand threads at once; but it by no means followed that a labourer,

with steam-power and a ploughing-machine, should turn over perhaps scores of acres in a day. Some steam machinery, waiving all imitation of the long series of old manual processes, might strike off the required product from a raw material almost at a blow; but it did not follow that a steam cultivator ought therefore to transform a hard foul staple-soil into a clean crumbled seed-bed by one magical rasp of its tooth. Theory forgot that the farmer produces in partnership with Dame Nature (who, like other elderly females, will take her own time at the pay-box, no matter how eagerly commercial considerations may be thronging to press her onward). Prepare your corn land with the utmost celerity of execution; still, the reaping-machine will follow some nine months after the drill; and one seed-bed a year is (with a few exceptions) the extent of your possible performance. Exhaust chemistry for manures to pamper pedigree grain and roots: the yield of your one crop per annum is still confined within narrow limits of increase; and the *maximum* of the most valuable produce restricts to comparatively few shillings per acre the sum you may profitably expend upon a seed-bed. Certainly, the low value of what you can reap or feed off the slow soil debars you from any such *coup de main* operation as grinding up (by a travelling earth-mill and the power of James Watt's great kettle, pump, and fly-wheel) a stone-baked clay into fine powdered mould—say some 1500 tons' weight on each acre. And besides, another consequence of having to conduct tillage out of doors is that, even if a seed-bed off-hand could be pecuniarily afforded, it would not answer the purpose for which it was designed. Nature, the farmer's indispensable partner, claims her share in his toils, and imposes the conditions under which alone he can secure a seed-bed preserving a pulverulent matrix for his plants. And as you cannot shovel the whole staple-soil of a field into some vast mignonette-box, to water it, warm it, or shade it at will, the task left for your mechanical tillage is simply to facilitate that tedious but inexpensive aerial action which (beyond the wit of man to imitate) fructifies while reducing tough clods into tilth. Operating, then, in conjunction with uncontrollable natural agents, the husbandman can never supersede, but only remodel and improve the world-old patient delving and uprooting and exposure of masses to atmospheric agency; he can but slice and dig and break up, and then, in some lighter after-process, crush and shatter and disintegrate clods replete with softening moisture or burst by ice and thaw; while, incidentally, he destroys in premature burial myriads of germinating annual weeds, and parches up by exposure, or combs out for the ordeal of the furnace, the matted and creeping runners of ineradicable couch. "I had once to attack a fallow field"

(says a Buckinghamshire clay-farmer) "in a hot dry summer. By immense force, and tear and wear of horse-flesh, implements, and harness, I got it broken into lumps as big as horses' heads. These a cross-ploughing reduced one half; another ploughing got them down to cricket-balls; Crosskill's clod-crusher brought them down to the size of walnuts, and then to sugar-knobs, to beans, to peas; but they were hard fragments still, as unlike tilth as possible. But a single 'smashing up' (and perhaps a crossing before winter) kills the weeds in a dry autumn, and places the land so under the influence of the winter's frost, that the soil in spring is as light and loose as the freest loam in the country. Masses which still retain the form of clods you may kick into a powder over the ground; and 'stiff, adhesive clay' now barely soils the boots that in other circumstances would gather 10 to 20 pounds of earth a-piece." It is clear, then, that the "revolution" in field practice which everybody expects from a steam-driven implement must consist, of necessity, in perfecting, expediting, and cheapening essential processes already in use; or, if introducing novel modes of manipulation, doing this the better to carry out the same principles of tillage upon which the old tool-work was based.

Dismissing, then, all chimerical notions from the subject, I propose to show that we now possess forms of steam-cultivating apparatus attaining these three points—1, *superior quality* in the work done; 2, *greater rapidity*, and 3, *less cost* of execution, as compared with culture by animal power. And it follows from the foregoing considerations that future progress (whether from improvements in mechanism of working implements of traction, or from the success of a revolving digger), will merely render somewhat greater the profit already obtainable through the services of the rope-drawn tine and share. Steam tillage is by no means "in its infancy," though its results may be as yet only dimly foreseen and scantily realized; as appears from a very simple but forcible consideration put by Mr. J. C. Morton, in his report of the trials at York last year. "A 4-horse team and plough weigh more than 40 cwt.; and all this goes trampling and sliding from end to end of the clay field that is being ploughed over every 10 or 12 inches of its width; and thus of course a floor is formed beneath the staple, hindering drainage and the entrance of air, impeding the downward penetration of roots, &c., &c. We want a tool weighing not more than 4 or 5 cwt. for every foot in the width worked by it, carried on wheels so as not to close the surface over which it travels, and driven by a power which shall not press upon the land that is being worked. All this we have in the steam-driven ploughs and cultivators that were seen at work yesterday: the ploughs

employed weighing not more than 5 to 7 cwt. per furrow, the cultivators from 4 to 5 cwt. per foot of width, and both are carried on large wheels at wide intervals, thus traversing the field but once to every 4 or 6 feet width. The engines driving them either travel along the headland, or they stand in one spot, or altogether out of the field. In both cases the tools can be drawn with wonderful effect through sun-baked clay which horses could not touch; in both cases (supposing the land to be fit for horse-work) the mischief done by drawing a heavy tool across the land that wants loosening and cultivating is reduced to a *minimum*; while for speed of work, in order to the full use of the short times in a year when clays are fit for cultivation, superior quality of tillage, and its much lower total cost, as compared with horse-labour, the advantages of steam-power are in both cases beyond a question."

In selecting proofs from the great mass of evidence which is cumulating every day, I may, first of all, take steam culture as represented in

THE TRIAL FIELDS AT WORCESTER.

Without recapitulating the details and descriptions which have appeared in this Journal—in my 'Account of Steam-Cultivation' (vol. xx.), in Mr. Frere's paper 'On the Present Aspect of Steam-Cultivation' (vol. xxi.), and in the Stewards' and Judges' Reports of Chester, Warwick, Canterbury, Leeds, and Battersea Meetings (see the vols. for the years respectively)—I will very briefly describe the several forms of apparatus now competing for public patronage.

Some systems familiar to visitors of our "country meetings" have been abandoned. No such thing as a locomotive engine travelling over the land, yoked to one or more traction-implements, appeared at Worcester. And though a locomotive-engine, delving the soil by rotary spades, has been exhibited at the agricultural exposition of Lille, our English inventors have at present no real embodiment in wood and metal of the mechanical idea so philosophically and pictorially placed before us in the 'Chronicles of a Clay Farm.' Steam-tillage in 1863 consists in dragging a traction-implement with a wire rope (or a substitute for it), hauled either by a stationary motive-power, or a motive-power moveable along the headland.

Leaving out of view the so-called "traction" engines, or highway and farm-road locomotives, we find "entered" in the Worcester Catalogue the steam-culture machinery of thirteen different exhibitors.

Mr. Thomas Beards, of Stow, near Buckingham, showed a plough adapted for any system of haulage. A rectangular iron

frame upon two furrow-wheels and two land-wheels, carries at each end a lever-frame with two plough-bodies, for turning over two furrows at once; and the implement traverses backward and forward, without turning round at the ends of the field, the two sets of ploughs being alternately dropped into the ground or held aloft in the air by chains and a barrel upon the top of the frame. This is a modification of the "balance" or "equipoise" principle exhibited by Messrs. Fiskien at Carlisle in 1855.

The implement of Mr. William Steevens, of Hammersmith, is also designed for any system of rope-traction. Two sets of ploughs pointing towards each other, are so hung within a main carriage-frame (with steerage-wheels) as to rise or fall with a parallel motion—the share-points and mould-board heels together; the bell-cranks and rods which effect this also balancing the two sets, in order that they may be easily lifted or lowered. A scale of inches upon the main frame marks the depth to which the ploughs are set, and the depth of the furrows can be instantaneously altered without stopping the implement. The plough-bodies can be removed from their respective frames and replaced by cultivating-tines; and again, instead of these, a harrow, taking 10 to 15 feet breadth at once, may be affixed below each of the rising and falling frames. There seems to be no reason why double-breasted or ridge-ploughs, or, indeed, almost any form of tillage tool, should not be added at will to the fundamental framing. Mr. Steevens has also produced an improved rope-reporter, enabling the rope to be readily lifted off the roller while the plough is passing. The work accomplished by the implement (worked by Messrs. Howard's form of tackle manufactured by Messrs. Garrett) was certainly of good quality, though a breakage occurred from lack of strength for excessively hard operations.

Mr. J. A. Williams, of Baydon, Wilts, has directed much attention to combinations of implements for steam-power. One of his arrangements consists of a large field-roller, with one heavy drag-harrow before and another behind it, set in a rectangular frame, which is pulled backwards and forwards without turning. Two lighter harrows, hung, one at each end of the frame, are raised when preceding, but lowered into work when following, the heavy drags and roller. Another set of light harrows, or a chain-harrow, is attached at the side; the whole covering a breadth of 13 feet, but adapting the position of the several implements to all inequalities of surface. The steerage is effected by simply diverting the rope to one side or the other, more or less out of the line of draught. For reducing a roughly broken-up surface, at a large acreage per day, this is a very efficient and economical machine. Mr. Williams' cultivator carries its tines

in lever-bars, which rise and fall of their own accord, like the coulter of a drill, taking 6 feet width at once. For these tines may be substituted three "double-tom" or ridge-ploughs, by which land is ridged for turnips, or laid up for winter exposure at a wonderfully rapid rate. This implement is turned at the land's end by the action of the ropes, passed round the fore part in bows, which also hold off the tail-rope in its proper place. The same practical exhibitor has also a land-presser for steam-power, so constructed that six wheels press as many furrows at once, each wheel riding independently of the rest.

Mr. C. Clay, of Wakefield, has a cultivator of peculiar action. The tines are fixed to cross-bars, which are at liberty to rotate part of a revolution; so that when the implement begins its journey, one-half the tines enter of their own accord into the ground, while the other half (pointing in an opposite direction) simultaneously rise out of work. Hence the workman has only the steering to manage. The implement runs upon a single pair of wheels.

The rotary rolling forker, which was a familiar object at the Society's meetings a few years ago, has reappeared in the modified form of a digging-machine, invented by Dr. G. Ager, of Aylsham, and exhibited by the manufacturers, Messrs. E. R. and F. Turner, of Ipswich. A set of rowels of large diameter, with curved tines or teeth, being set in motion by the onward progress of the implement, penetrate and lift up the soil; while a second and smaller set of rowels, driven by toothed wheels and pitch-chains from the former set, clears the teeth of earth, much as the revolving spurs of a Norwegian harrow clear each other. The machine is very similar to one which the Rev. S. Smith, of Lois Weedon, invented and worked with admirable effect a few years ago. The work produced by the present digger is reported by employers to be very effective and valuable, and to be performed with a comparatively small expenditure of motive power. The forked tilling part of the machine is placed in a circular frame, to which the hauling-ropes are attached, and is turned half round upon friction-rollers in this frame, for working in the opposite direction.

Among the articles designed to aid steam-tillage, I must not omit a clever little contrivance of Mr. W. S. Underhill, of Newport, Salop. To prevent that serious delay—the breaking of a rope—and to preclude the risk of great damage from sudden obstructions, inattention to signals, &c., the rope is attached to the implement by a spring hook—that is, a hook so made as to release itself from its hold when a spiral spring upon its shank becomes compressed beyond a certain point; and this yielding strain may be set to any number of cwts. at pleasure. The

device is good, and the cost low ; and the hook is adapted to any apparatus not fitted with "taking-up gear" upon the implement.

Coming now to distinct systems of haulage, I find entered in the Catalogue, but not present in the Show-yard, the apparatus of Mr. W. Fiskin, of Stamfordham, Northumberland. The peculiarity in the invention (which has undergone great modifications since its early appearance in Scotland in 1852, and its exhibition at Carlisle in 1855), consists in conveying the power from a stationary engine by means of hemp-rope running at a high velocity. At first the windlass, with ploughs attached, worked its way to and fro by coiling or by gripping a fixed and immovable wire-rope ; then the implement was made to travel by means of a drum armed with cutting blades that laid hold of the ground ; and lastly, this has been abandoned for the present plan of two self-moving anchor-windlasses, one on each headland, alternately coiling a single wire-rope which pulls the plough,—the endless hemp cord mounted upon porters, along one headland and across the field alongside the furrow, transmitting power and motion to the two windlasses. The price of the apparatus is marked excessively low ; but now that we have learned to carry wire-rope clear off the land, and thus to take power to almost unlimited distances with very little waste in friction, I do not perceive what special advantages could be gained by the present form of this invention.

The apparatus of Mr. W. Smith, of Woolston, Bletchley, Bucks, is so well known that a description would be superfluous ; and only a few minor alterations appeared in the tackle at Worcester. The double-cylinder 10-horse ordinary portable engine had an additional band-wheel, formed in one piece with the fly-wheel, giving a choice of two speeds for lighter or harder work. The stationary four-wheeled windlass, with a couple of coiling drums ; the claw-anchors let into the ground by digging holes ; and the simple, strong, light, three-tined and five-tined cultivators, turned round at the ends of the work by the action of the ropes, present no apparent novelty in construction. The pulleys or snatch-blocks, however (four, five, or even six in number, according to the shape of the field), have been made with a deeper and more durable centre-boss rotating upon a longer pin ; and the rope-porters standing upon curved wood rockers cannot tumble over, and are easily moved. In addition to the two grubbers of different sizes, Mr. Smith showed his combined cultivator and corn-drill (with grubbing tines and seed-coulters on one lever frame), which has been much lightened, improved, and cheapened in price since last year. This machine, thoroughly tested in extensive practice, enables the farmer to make a seed-bed out of whole ground, and sow it at one operation ; with an admirable

tilth, perfectly straight rows completely finished up on the headlands as elsewhere, the seed planted at regular depth, and all without the trampling of a single hoof. It is also adapted for haulage by other systems of rope-traction.

Mr. E. Hayes, of Stony Stratford, Bucks, has introduced various modifications into this system of a stationary engine and windlass, and rope laid out round the field. Between the two winding drums upon the same axis are hung three riggers or band-wheels, any one of which may be driven at pleasure by a belt from a broad rigger or sheave on the engine fly-wheel. The middle rigger on the windlass is simply a "dead rigger;" each of the others actuates at a slower speed one of the drums, by means of spur-wheels inside. To reverse the action of the drums, then, it is only necessary to slip the belt from one outside rigger to the other, without taking any toothed wheel out of gear, and without stopping the engine—which is a source of trouble and delay when the engine has but a single cylinder. The revolution of the slack or paying-out drum is arrested, ready for the reverse motion, by the momentary pressure of a steam-piston brake. But no attendant is needed at this windlass; for Mr. Hayes leads out cords from the windlass around the field, by which either of the anchor-men instantaneously shifts the reversing bar, when the implement arrives at the end of its furrow. So that no signalling is required, except in case of obstruction to the plough while on its journey; and this enables the farmer to work in the thickest fog, or by moonlight in a pressing season, with perfect safety to the machinery. Any implement adapted for rope-traction may be employed with this apparatus.

The improvements of Messrs. J. and F. Howard, of Bedford, embrace all parts of the so-called "round-about" system. Their 10-horse double-cylinder ordinary portable engine, actuated the stationary windlass by means of a spindle with universal joints, in place of a driving-strap, which is liable to slip in wet weather. The two coiling-drums are hung upon eccentric bosses, or hollow axles, both upon one carriage axletree; and by altering the position of these eccentrics either drum is raised or lowered at pleasure, in order to place its toothed flange in or out of gear with one of the pinions on the first-motion shaft above. Thus a very light, though powerful, two-wheeled windlass is secured; the stopping and reversing are easy; the motion of the drums can be stopped without shutting off steam; the slack or loose drum, dropping upon a fixed block, becomes its own brake; and the amount of frictional pressure in this braking action can be regulated at will. The next point that meets our attention is the provision made for holding up the rope off the ground; not only to save wear, but to economise motive-power. A tight or pulling

rope will always hold itself clear above the land, even upon low rope-porters; but a slack or outgoing rope, even if passed over porters 3 or $3\frac{1}{2}$ feet high, commonly trails by far the major part of its length along the ground. Now, it appears from the dynamometer experiments of Mr. J. F. Harrison, C.E., and Mr. J. C. Morton, in May and June last, that a very considerable proportion of motive-power may be sacrificed by imperfectly carrying the rope. The draught of 440 yards of Mr. Smith's rope, wholly dragging upon the ground, and passing round three pulleys, was 3 cwts.—equal to about half the weight of the rope; and the draught of 700 yards of Mr. Fowler's rope, wholly dragging on the ground, and passed round the clip-drum and one pulley, was $4\frac{1}{2}$ cwts.—equal to more than one-third the weight of the rope. When imperfectly carried upon rope-porters, the draught was diminished nearly one-half; and when the rope was held clear from contact with the ground, the draught was only $\frac{1}{2}$ of a cwt.—only a sixth of the draught when trailing its full length. Hence we learn that, in dealing with fields of tolerable size, 3 or 4 cwts. of draught (representing, at a pace of $3\frac{1}{2}$ miles per hour, 3 or 4 mechanical horse-power) may be wasted from not carrying the rope at all; while there may be a difference of 2 or more horse-power between partially and perfectly supporting the rope above the land. The necessary tightening of the slack rope might be effected by applying a brake to the paying-out drum, but it would be very undesirable to do this. It was found in the aforesaid experiments that, while the draught of a certain length of the Woolston rope (running over porters at intervals of 20 to 40 yards) was $2\frac{1}{2}$ cwts. when the slack drum ran loose, it was only 2 cwts. with the brake applied as usual: so that partial braking is an advantage. When the brake, however, was pressed so hard as to keep the slack rope entirely off the ground, the draught rose to 4 cwts. A simple brake, then, while saving a slight amount of power, as commonly used, would involve a great loss by friction, if employed to hold up the rope completely. Accordingly Messrs. Howard adopt a method of returning to the pulling rope a portion of the strain which retards the slack or outgoing rope. At a few yards' distance from the windlass a compensating pulley, loosely hung between two fixed pulleys, pinches the hauling rope into the groove of one pulley, while at the same time pinching the slack rope into the groove of the other pulley—so that the outgoing slack rope helps to haul the pulling rope; and while the pressure in this self-acting apparatus is proportioned to the strain exerted by the windlass upon the hauling rope, there is no pressure at all when the rope is doing no work—thus enabling the portion of spare rope to pass freely to the windlass as the implement commences its journey. The

rope is more effectually carried, owing to this contrivance, than it is by the brake alone; but what proportion of power is thus economised has not been well ascertained. The back and forward bending of the ropes between these additional pulleys must prove a source of considerable wear; and hence it is very desirable that whatever compensating movement is devised should be applied to the windlass drums, rather than to the ropes. Mr. Fowler has such a windlass with compensating brake; but, owing to the varying speeds of the drums (according as more or fewer layers of coils are wound upon them at different parts of the journey of the implement), only a portion of the retarding strain is returned to the hauling drum. Probably a simpler plan will be introduced, in which only a single layer of coils will be wrapped upon either drum.

Messrs. Howard's rope is laid out round five or six pulleys (according to the figure of the field and the position of the windlass), and these are of larger dimensions than the Woolston pulleys—which Mr. Smith considers large enough to be still portable (though the rope in passing them is bent round a curve of but 13 inches' radius). With improvements in carrying the rope (without an excessive number of rope-porters), some change will probably be required in the present system of claw-anchors, which are already troublesome enough in some situations; permanent posts, or temporary posts and chains, being available in the absence of self-travelling anchorages. The Bedford rope-porters are remarkably handy for moving from and replacing under the rope; and those porters which are out of the track of the implement are admirable for catching a rope that rides or rebounds—as when crossing over a hollow. I need not describe the cultivator with tines that point both ways (for travelling to and fro without turning), and rock of their own accord,—so that when the fore point is depressed, the hinder one is slightly raised. It is remarkably light, and strong too, and shares of various widths—from 2 up to 13 inches—enable it either to cleanly cut all the bottom, or break up without cutting when the ground is suitable. Two sizes of this implement are made, with 3 and 5 tines respectively. For reducing the broken soil a set of double-action harrows is employed, in a peculiarly light framing, steered in a similar manner to the cultivator by a lever-movement altering the lock or set of the forward wheels. Messrs. Howard's new plough consists of two sets of plough-bodies pointing towards each other, upon two lever frames, which cross at their inner ends within a short main-frame having one large furrow-wheel and a couple of land-steerage wheels; all three wheels standing very near together midway of the length of the implement. But the two sets of ploughs are raised or lowered into work independently of

each other ; the weight of each set being counteracted by separate spiral springs coiled in boxes, instead of either wholly or partially counterpoised by the weight of the other. And to neutralise the tendency of the ploughs to rise out of very difficult work (particularly on hilly land), the action of the springs is so adjusted as to lift only a portion of the weight when the ploughs are in position for work, but sustain the entire weight when the set is raised into the air. The total length of the 4-furrow implement is about 9 yards (the same as of Mr. Fowler's plough). What little of its work I have seen is first-rate ; and a high opinion of its performance will be found in the Judges' Report. Of course scarifying tines, digging-breasts, or subsoil shares can be substituted at pleasure for the clean shares and sweeping mould-boards which the Britannia Works are so well able to turn out.

Before proceeding to notice machinery on the moveable-engine system, I would add a word of caution respecting the employment of second-hand thrashing-engines for steam tillage. A 7 or 8-horse engine, working at 45 lbs. pressure, is quite unable to perform the work ordinarily expected of a steam cultivator or plough. On land where $5\frac{1}{2}$ inch deep ploughing (with a horse-plough) gave a fair draught for a pair of horses, Messrs. Morton and Harrison found the draught of Mr. Smith's 3-tined grubber, when taking 30 inches breadth at a time, 5 and 6 to $6\frac{1}{2}$ inches deep, to be 12 up to 19 cwts. ; and again, the draught of Messrs. Howard's 3-tined grubber, when taking 3 feet breadth, 4 and $5\frac{1}{2}$ to $6\frac{1}{2}$ inches depth, was 12 up to 21 cwts. At a pace of $3\frac{1}{3}$ miles per hour, these cwts. represent so many horse-power ; far beyond the nominal horse-power of the aforesaid thrashing-engine. By driving from say a $3\frac{1}{2}$ feet sheave, instead of from the 5 feet fly-wheel of the engine, the obtainable draught may be increased—of course at a corresponding sacrifice of pace in the implement and of the acreage done per day. But if the engine boiler be sound and strong and the fire-box well strengthened with extra "stays," the engine may be safely worked up to 60 lbs. pressure, giving out proportionally more than her nominal power. Engines expressly made for steam cultivation are extra strong, capable of working up to double their nominal horse-power ; and it is with these that expeditious and therefore cheap cultivating and ploughing are accomplished.

Coming now to moveable-engine forms of apparatus, I will first refer to that of Messrs. Coleman and Sons, of Chelmsford. The engine travels at intervals along one headland, always opposite the end of the work ; and from two coiling drums upon a longitudinal axis at the side of the boiler (and unavoidably of too small a diameter for the best usage of the rope), two ropes are led side by side across the field to two separate and inde-

pendent implements. These are 5-tined cultivators, with tines that can be instantly set in or out of the ground. Each implement in turn is alternately hauled in work toward the engine, and then pulled backwards out of work to its next starting point; but each traverses only half the length of the field, one beginning where the other finishes its furrow, midway between the engine and an anchored pulley on the far headland. This arrangement (proposed by myself before the Society of Arts in 1858) enables the use of only a very slight anchorage, and a light rope around it, extending the length of the field, and connecting the two implements together; seeing that the working strain is only exerted directly between the implements and the engine. This thin rope is taken up or let out for varying lengths of furrow, by a drum upon one of the implements; and a self-acting brake upon the engine preserves the tightness of all the ropes, necessary for holding them off the land upon the rope-porters. Owing to the implements being single instead of double, they occupy less room and leave narrower headlands; working up to the engine, they can dispense with signalling; and there being neither windlass nor travelling anchorage, the whole tackle is removed from field to field by the locomotive engine, and set to work in a very short space of time. The grubbers make good work, and purchasers of the apparatus speak highly of its performances; but the system has not at present been adapted to turn-over ploughing.

Mr. John Fowler, of 28, Cornhill, and of the Steam-Plough Works, Leeds, has three distinct forms of steam-cultivating machinery; all based, however, upon the use of the moveable engine. In the simplest, an endless wire-rope is distended between a "clip-drum" under the boiler of a locomotive engine on one headland, and a pulley upon a self-travelling anchorage upon the other headland. The groove of the drum, being made of nipping pieces in pairs, pinches the half-turn of rope in exact proportion to the strain or draught, and may be set at pleasure to any degree of pressure; so that the rope is held without slipping in the grip of a 10, 12, or 14-horse engine, working up to double its nominal power. But though there is considerable wear of the clipping-pieces (which are very easily and cheaply renewed), it does not appear from experience that the rope itself suffers any more than it would from careful coiling upon a winding-drum. By means of a "taking-up" or "slack" gear upon the implement, the pulling rope employs about one-sixth part of its strain in maintaining a considerable degree of tension in the back or return rope; and by this self-acting contrivance, the entire length of rope is held up clear off the ground, riding over the friction-rollers of the rope-porters. The economy of motive power thus

obtained is so great, that only trifling improvements in this direction remain possible to future inventors. It has been shown from Messrs. Morton and Harrison's experiments, that, out of a total draught of $28\frac{1}{2}$ cwts. due to the work (with a 350 yards furrow), 1 cwt. is consumed in moving the rope and pulley, and $\frac{1}{3}$ of a cwt. more in moving the anchorage forward; leaving no less than $27\frac{1}{6}$ cwts. (or 95 per cent. of the total draught at the clip-drum) engaged in hauling the implement. And, deducting the average draught of the plough when out of work— $2\frac{3}{4}$ cwts.—the result is that $24\frac{1}{2}$ cwts. (86 per cent. of the total draught) are actually applied to the severing and upturning of the soil. And considering further how largely the peculiar sources of friction and cohesion in horse-drawn implements are avoided in the steam plough and steam grubber (so that only minor improvements can be made either in the implement or the hauling apparatus), we see that little room can possibly remain for some novel machine which theorizers are expecting will one day accomplish two or three times as much tillage by the same expenditure of power. Saving of labour, too, can hardly be an important item in any future invention; seeing that to work this apparatus of Mr. Fowler requires only an engine-driver and ploughman, one anchor-lad, and a couple of porter-boys; of course, with the addition of cartage of fuel and water.

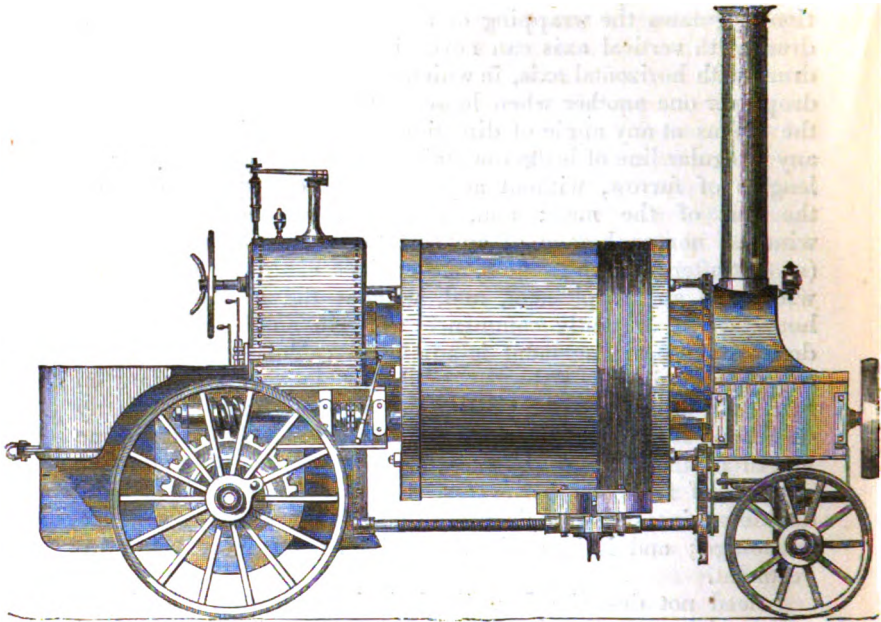
To accommodate customers who prefer a lower-priced machine, at the sacrifice of having to remove the engine, separate windlass, anchorage, &c., by horses, Mr. Fowler places a clip-drum with the requisite toothed-wheels and a driving-rigger, in a self-travelling carriage-frame, which has cutting flanges attached to its wheels to prevent sidelong slipping in the direction of the ropes, these flanges being removed when shifting from field to field. A common portable 8 or 10-horse engine, temporarily attached to this drum-carriage by a sort of iron shafts, follows it along the headland; a V-grooved rigger on the crank-shaft driving a similar rigger on the drum-carriage by means of a peculiar endless-chain. This chain is composed of hard-wood blocks, wedge-shaped to fit the V groove, and connected together by iron link-pieces. It conveys the whole force of a powerful engine, without slipping, no matter how loosely the chain may hang, and with large allowance for different angles of position of the two riggers; and the wear is probably very trifling indeed.

A third set of Mr. Fowler's machinery consists of two locomotive engines, one on each headland, hauling the implement to and fro, by means of a single length of rope, alternately wound and unwound by ordinary coiling drums, one beneath the boiler of each engine. A beautifully ingenious and very simple contrivance (in which is employed a travelling pinion gearing with

two differential spur-wheels, demanding diagrams for an explanation) regulates the wrapping of the coils; but winding upon a drum with vertical axis can never be so neatly done as upon a drum with horizontal axis, in which case the coils are not liable to drop over one another when loose. As the rope can feed on to the drums at any angle of direction, and the engines (following any irregular line of hedgerow) take up or let out rope for varying lengths of furrow, without any hindrance or any attention on the part of the men; and, moreover, as there is neither windlass nor anchorage of any sort to be shifted or set down (so that after finishing a field, the engines can move off at once with rope and implement, and, without the assistance of any horse at all, instantly commence work in another field), this double-engine arrangement is admirably calculated for districts of irregular-shaped inclosures, and especially for working on hire. Of course, the slack half of the rope is only imperfectly carried; but then, all the rope out at once is only of the same length as the furrow. In economy of performance, unless the number of removals be excessive (as in contract work), the double-engine system falls behind that of the single-engine and anchorage; and it is, at the same time, a far more heavy investment.

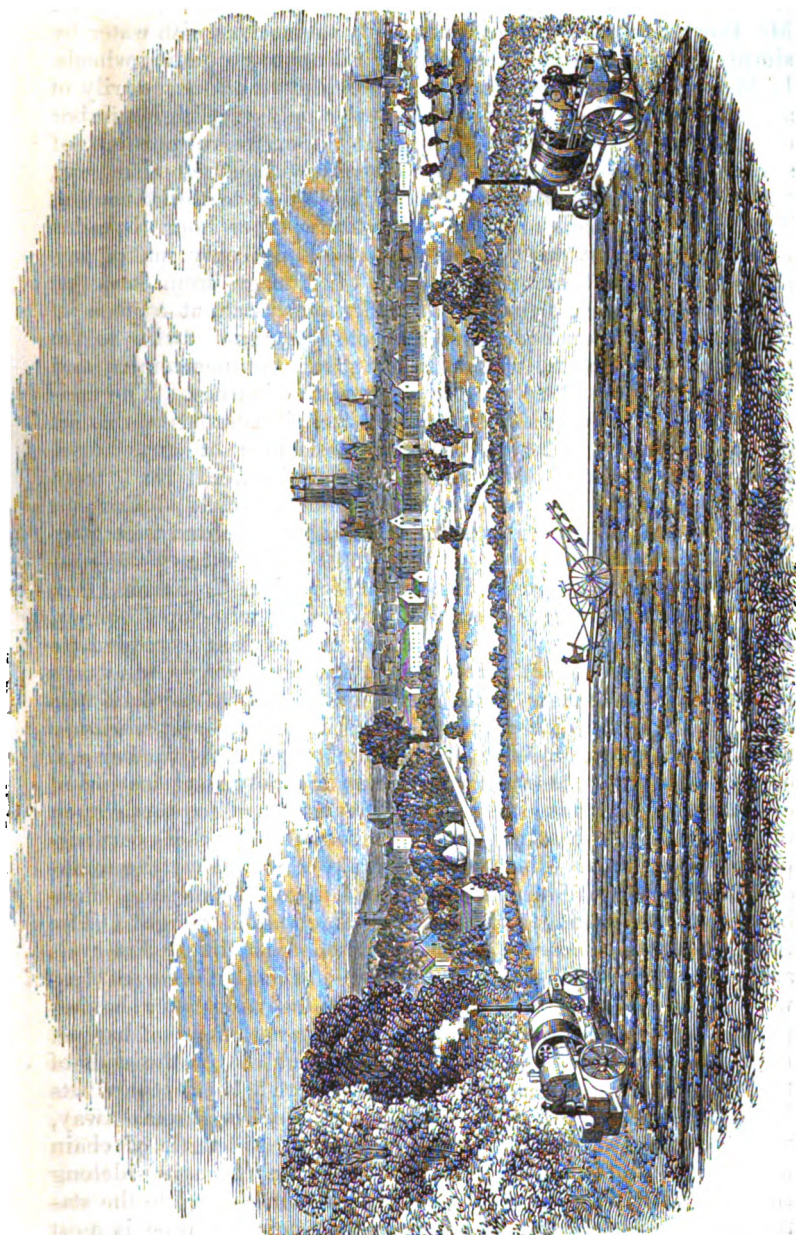
I need not describe Mr. Fowler's implements. The 3-furrow or 4-furrow plough, balanced upon a pair of large-sized wheels, can be fitted up with cultivating-tines, or the plough-shares can be used with short prong mouldboards (or "digging-breasts"), which perform much more effectual tillage than any other cultivating-tines whatever. Trench ploughs, subsoilers, or double-breasted ridge-ploughs, may all be used on this implement. Another implement is the 5-tined or 7-tined cultivator, similarly balanced upon a pair of wheels, the tracks of which are obliterated by the tines following them. Another is a cultivator and subsoiler combined, working to a depth of 18 inches. Another is a set of heavy harrows, hung in a light framing, to which the steering and slack-rope gear are attached. For working behind the plough, a 3 or 4 furrow land-presser is provided, with seed-box attached; and a corn-drill is also supplied, to be worked alongside the cultivator, thus making a seed-bed and sowing at one operation.

The double-engine system is carried out in a novel manner by Messrs. W. Savory and Son, of Gloucester. The illustration given in page 376 shows the form of his engine. A shell drum, of 6 feet diameter, without arms or spokes, incloses the body of an engine-boiler,—revolving upon three pairs of friction-wheels, which are supported in brackets upon the boiler. The cylinders are placed transversely across the end of the smoke-box, over



Savory's Engine.

the steerage wheels; and the long crank-shaft passing inside the drum drives it by pinions and internal gear, and also by means of a screw or worm gives motion (at pleasure) to the hind carriage-wheel axle. The drum will contain 500 yards' length of rope in a single layer of coils; and a couple of guide-rollers traversing the length of the drum by means of a rotating shaft, threaded like a screw, regulate the coiling so perfectly that the rope never overlaps itself; thus avoiding any grinding or damage from acute bending. Two engines thus fitted haul the implement (a Fowler's plough or Howard's grubber, &c.) to and fro from one headland to the other: the guide-rollers deflecting the rope when the furrow is not quite at right angles to the direction of the headland; while, in case of an acute angle of direction, the engine can be moved forward and steered so as to present its broadside always toward the line of work. This setting of the engine askew may not be very advantageous to a moist headland; but there is plenty of time for the operation; one engine having nothing to do but to take up its position while the other is hauling the implement. To feed the boiler with water while the engine is at rest, Messrs. Savory employ a small "donkey-engine," placed (like the steering mechanism and reversing



Savory's System of Steam Cultivation.

clutches) close at hand, under the command of the engine-man. Mr. Fowler's "double" engines supply themselves with water by simply running disconnected with their drum or propelling wheels. In Messrs. Savory's arrangement the cylinders are necessarily of short stroke, giving out their full power only at a high number of revolutions per minute (unless at an excessive pressure of steam); and, by driving the drum directly without reducing gear, too great a speed is obtained for any implement to work steadily. Travelling at a pace of more than 4 miles per hour (5 miles per hour in light work), the implement not only makes imperfect work, but incurs great risk of damage from land-fast impediments; and, besides, a broader cultivator, at a pace of $2\frac{1}{2}$ to 3 miles per hour, would waste less time, owing to the few number of bouts, each with its steady commencement and slackening of speed toward the close of the journey. The facilities of the twin-engine principle are well illustrated by this set of apparatus, which, without the assistance of any horse, brought itself along 30 miles of up-and-down-hill road from Gloucester in one day, and shifted from field to field, losing but a few minutes in gathering up or leading-out rope and taking up position ready for work.

One more invention remains for notice. Mr. Collinson Hall, of Navestock, Romford, Essex, substitutes for wire-rope a chain, formed of $\frac{1}{2}$ -inch round steel rods, 18 inches long, coupled together by pairs of flat plates 4 inches long, with connecting rivets; and an endless chain, thus made, passes one half-turn round a drum beneath a moveable-engine boiler, and similarly round a pulley upon a self-travelling anchorage at the further end of the field. But the drum and pulley are polygonal instead of circular; and the link-chain is hauled by means of cog-teeth upon the drum taking into the apertures provided by the coupling-plates of the chain. The breaking strain of the plates (the weakest point) has been found to be about 14 up to 22 tons; the chain being probably stronger than wire-rope of equal weight. The merit of the invention is in its supposed durability. The rods and plates of this link-chain (exhibited by Messrs. Turner of Ipswich) present but little appearance of attrition after having ploughed 400 acres; and it is affirmed that not one rivet has yet been broken. The wear must take place chiefly on the ends of the rivets and in the eyes in which they work; but if the rivets be purposely made of softer metal, they alone will wear away, and the whole of the 2800 rivets in 800 yards' length of chain may be replaced for some 30s. As the chain (from its sidelong rigidity) will not wrap upon a drum, it is unadapted to the stationary-windlass system, where greater economy of rope is most of all desirable; and, moreover, this necessitates a tedious unbolt-

ing and folding of sections of the link-chain for removal in a cart, instead of quickly and conveniently coiling it upon the engine-drum. Again, the chain cannot ride upon porters, owing to the excessive amount of play or hinge-action so demanded of the rivet-and-plate joints; hence incurring a very considerable waste of motive power. The comparative draught of a given length of this link-chain and of wire-rope trailing upon the ground has not been ascertained; but the weight of the present link-chain is 3lbs. per lineal yard, or from one-half up to twice more than that of the wire-rope of different sets of apparatus. Of course, it is a mere sophism to excuse the heavy drag of a rope or chain along the ground by saying that a cwt. or so more coal per day will give the extra power required. For when an engine is already working up to her full power compatibly with safety, an additional one, two, or three horse-power can be obtained only through a stronger boiler, a larger cylinder, and in fact, by an entire engine of bigger dimensions and higher prime cost.

As applied to the twin-engine system, Mr. Hall's traction-medium deserves consideration. Instead of two 12 or 14 horse engines, each idle in turn while the other is hauling a single length of rope, he employs two 6 or 7 horse engines, both simultaneously hauling an endless link-chain, and thus accomplishing as much work as engines of double the power, weight, and first cost. The back, or return ply of the chain being always tight, can be mounted upon low porters; and the other ply along the track of the plough may be similarly upheld where in advance of the implement, though left upon the land where running slack. For varying lengths of furrow, a portion of spare chain is carried folded upon the implement; a hook that will lay hold of the chain at any point allowing one or more links to be left out or taken up at pleasure. I do not know why Mr. Fowler's twin-engines should not be of lower power, and work an endless wire-rope with clip-drums; thereby lightening the apparatus for a deep and sticky district, as well as sparing the contract proprietor or company several hundred pounds of purchase-money. The objection to two engines working at once is the difficulty of securing simultaneous starting and stopping: it remains to be seen how far this may be overcome,—perhaps by signal rope laid out between one engine and the other.

My account of the steam-tilling machinery at Worcester being intended to touch only upon points not fully elaborated in the Judges' Report, I leave all details of the four days' competitive field-work, merely drawing certain inferences, either from my own personal observation or from the official statistics and remarks. Comparing self-locomotive apparatus with that working a com-

mon portable engine, it appeared (in the course of the trials) that the latter (if cultivating at the rate of about an acre per hour in moderate-sized enclosures) would lose more than two hours every other day in removing to fresh ground half a mile off, if 4 horses were employed for the operation; or it would require 8 horses in order to shift in about one to one-and-a-half hours. On the other hand, a couple of self-travelling engines would move the same distance in twenty-five minutes, without any horse at all; while a single locomotive engine with an anchorage would take a longer time than this, but equally dispense with the assistance of horse-flesh. Comparing the amount of labour required, we find the stationary-engine apparatus to be manned as follows:—Mr. Smith's, 6 men; Messrs. Howard's, 5 men and 2 boys; and Mr. Hayes', 4 men and 2 boys. The moveable engine employs hands as follows:—Mr. Fowler's separate-drum tackle, 3 men and 3 boys; Mr. Fowler's other tackle, 2 men and 3 boys; Messrs. Coleman's apparatus, 5 men and 2 boys. Mr. Fowler's, like Messrs. Savory's twin-engine plan, is worked by 3 men and 2 boys. In all cases the labour of water-carting is additional. As regards the relative cost per acre of a given operation, I consider that no accurate test was furnished by indurated ground torn up into pieces of all sizes, and at average depths which, after the most careful measuring in a few spots, must remain open to differing individual opinions. Mr. Fowler's moveable 10-horse engine, and Messrs. Howard's stationary 10-horse engine, completed their equal plots (of less than 2 acres) in very nearly the same time, with about equal consumption of fuel; but the former worked five times at once, and the latter only three. Mr. Smith's stationary 10-horse engine, with a 3-tined cultivator, working at the same depth as the other two, and making the most efficient tillage, burned somewhat more coal, and occupied one-half more time. Messrs. Savory's two 10-horse engines finished their plot in rather less time than either Messrs. Fowler or Howard's machines, but with nearly two-thirds more coal. In turn-over ploughing $1\frac{1}{2}$ acres each, Messrs. Savory, Fowler, and Howard, occupied nearly equal times. In cultivating a little over $1\frac{3}{4}$ acres each at Wadborough, Mr. Smith's 10-horse tackle consumed the least coal, but took the longest time; Mr. Fowler's 14-horse engine expended both the least time and smallest quantity of fuel; Messrs. Howard's 10-horse tackle consumed a trifle more coal, and was considerably longer in doing the work; and Messrs. Savory's two 10-horse engines, while taking less time than Messrs. Howard's, burnt considerably more fuel. But the unavoidable absence of reliable dynamometrical tests, and the impossibility of assigning any exact value to the several degrees of effectiveness in the different works,

forbid any minute deduction from these experiments as to the comparative economy of the competing machines. Mr. Fowler's two 12-horse engines, for instance, consumed as much coal as Messrs. Savory's, and spent more time than Messrs. Howard's—nearly as much as Mr. Smith's—in tilling about $1\frac{1}{2}$ acres; but then their work done by the digging-breasts was very superior to any other in the field. It may be taken as a general conclusion that a moveable engine,—working with less rope, fewer pulleys, and consequently less waste of motive power, while employing fewer workmen,—performs any given process at less cost per acre than a stationary engine can; and this point, together with the very low expense of all the steam-tillage done, is illustrated in the Judges' Report, where the percentage for interest and wear and tear is by no means too favourably assessed. But the reader should bear in mind that while Mr. Fowler's work with a moveable engine cost less money per acre than the work of either Mr. Smith's or Messrs. Howard's stationary engine, the difference in his favour would have been greater had the areas in the competitions been, say, of 20 acres each, instead of only some 2 acres each; seeing that the additional length of rope required by the round-about system becomes a serious drawback when surrounding a large enclosure, and not perfectly carried off the ground.

At the Worcester trials hard stiff loam was cultivated 7 inches deep by Mr. Fowler's 10-horse-power machine, at the rate of $9\frac{1}{2}$ acres per day, and a total expense (without removals) of 4s. 9d. per acre; and Messrs. Howard's 10-horse-power machine worked at the rate of half an acre per day less, and 2d. per acre more money. Ploughing $6\frac{1}{2}$ inches deep, with the same sets of hauling apparatus, was performed by Mr. Fowler at the rate of $7\frac{1}{2}$ acres per day, and a cost of 6s. 3d. per acre; and by Messrs. Howard, at the rate of 7 acres per day, and at 6s. 4d. per acre. But by way of contrasting steam-power performance with that of horses, I must cite one or two of the most memorable feats in the moister and more suitable fields at Leeds and Canterbury. At the latter trial, in 1860, in ploughing a strong loam (which, from the ascertained draught of a common plough at 6 cwts., would cost 12s. an acre if turned over by horses), Mr. Fowler's 12-horse engine, working with a pressure of 68 lbs. on the square inch, drove 4 “3-horse-furrows” at once, at the rate of 11 acres in ten hours; and the total cost was computed at 4s. 6d. per acre, instead of 12s. (the lowest price by horse-labour), though the excessive allowance of 20 per cent. was put down for interest and wear and tear. At Leeds, in 1861, Messrs. Howard's 10-horse engine scarified a strong and stubborn soil 5 or 6 inches deep, at the rate of $6\frac{1}{2}$ acres in ten hours, at a cost of 6s. 8d. per acre. Mr. Fowler's

12-horse engine scarified the same soil 7 inches deep, at the rate of $6\frac{1}{2}$ acres in ten hours, at a total cost of 7s. 2d. per acre. In land where the ploughing of a single furrow 8 inches deep required a draught equivalent to the power of 5 horses, the same engine ploughed at that depth at the rate of $5\frac{1}{2}$ acres in ten hours, for a total cost of 7s. 10d. per acre. Of course in reading these figures (as well as those of the Worcester Judges' Report) it should be borne in mind that, though ordinary wages are charged for the labour, the trained hands of exhibitors are masters of a larger daily acreage than could be expected from common farm workmen.

From the lessons of the trial field I now turn to the encouragements furnished in

FARM PRACTICE.

It may be possible to find more than one farmer who, having purchased steam-cultivating apparatus when its mechanical merits were less developed than at present, found only disappointment from the inefficiency of the machine or the scantiness of its valuable results. But we have now such a body of satisfactory evidence from large and small occupiers, upon every description of soil, and in all parts of the kingdom, that the difficulty is how to select examples of success that shall be more striking than others. I might give detailed descriptions of scores of farms under the tillage of Mr. Fowler's, Messrs. Howard's, Mr. Smith's, or some other machinery; but as the agricultural press has lately teemed with reports of steam farms, annals of steam culture, lectures, and discussions on the same great achievements of rural mechanism, perhaps I cannot do better than cull and condense the main facts that have as yet been made known, with the opinions of those who have had most practical experience in the matter. From the *Agricultural Gazette*, the *Mark Lane Express*, *Bell's Weekly Messenger*, the hundreds of good testimonials received by different inventors and manufacturers, and from what has been gathered by personal acquaintance with many cases of steam-farming, I will select some of the most prominent testimony to the value of the steam-plough. I disclaim, however, any attempt at "making out a case," or puffing steam cultivation by extravagant statements; much less am I conscious of being influenced by any bias for or against one form of apparatus more than another. My tabulated cases are merely such as chanced to yield the particulars required; and are probably average specimens of their class, instead of being picked and unusual examples.

Take, first, a synopsis of performances and expenditure with the machinery of our three principal inventors and manufacturers.

Most of the figures have been calculated from data given in the gross in printed reports from purchasers and employers. Some of the items are, of necessity, more or less arbitrary; some few sums are matters of estimate; and in one or two instances the cost price of the machinery is incorrectly stated for want of precise information. Perhaps I have committed some mistakes in characterizing the soil of particular farms, and in stating the number of horses there required in a common plough. Other errors may exist, though unknown; but the general truthfulness of the details may be relied on, and the final averages may be taken as fair data of practical steam culture in many different hands, and under very various circumstances. Removals and lost time are principally accounted for in the sum for wages, &c.; but in some instances a small addition ought perhaps to be made for horses, reckoning one removal (occupying say one-sixth to one-fourth of a day on an average of distances) due to about 20 to 24 acres,—as computed from a number of still later reports recently published.

The sums for rope and repairs are nearly all founded upon the outlay actually incurred; or (where the experience has been too limited) are charged in about the proportion averaged by the cases of longer experience. But the amount of "depreciation," or, in other words, the sum to be annually laid by for replacing, or, in other words, maintaining the machinery perpetually in good condition, has not been so well ascertained as the cost of rope and other working parts worn out or broken. Steam-ploughs, more particularly those with self-travelling or locomotive engines, have not been in existence for a sufficient time to show how long they will really last. The market value of a second-hand engine and set of tackle is, of course, no guide here, seeing that 25 per cent. of the cost price may sometimes be sacrificed by only a day's work (not from damage incurred, but from becoming "second-hand" instead of "new"); and while minor improvements are being continually added to each invention, purchasers will seek the newest form out rather than buy an old machine at half-price. For the sake of being over rather than under the mark, I have supposed the engine and apparatus, though every year repaired as far as wearing-parts and breakages are concerned, to become good for nothing and not worth a farthing at the end of ten years. I suppose the metal-work to rust and consume away, and the wood to decay, so utterly that a completely new "set" must be purchased every tenth year. Competent judges agree with me that this is an extreme supposition, and that I have consequently made the cost of work a shilling an acre, more or less, greater than a lengthened experience will hereafter prove it to be.

SYNOPSIS OF PERFORMANCES OF EIGHT OF MR. FOWLER'S STEAM PLOUGHS during the Year 1862. Calculated from Reports by the Employers of the Apparatus, published in the 'Agricultural Gazette,' No. XIX., 1863.

Number of Example.	Age of Steam-plough at close of year 1862.	Horse-power of Engine.	Work done.			Average of Daily Expenses, including Lost Time.				Repairs and Rope per Day.	Cost per Day.	Working Expenses per Acre.	Repairs and Rope per Acre.	Cost per Acre.	Price of Apparatus.	Interest and Depreciation per Day.	Interest and Depreciation per Acre.	Total Cost of Work per Day.	Total Cost of Work per Acre.	Depth of Work.	Size of Farm, Character of Land, and Price of Coal.						
			Acres Ploughed.	Acres Grubbed.	Total Acres.	Acres per Day.*	Wages and Water-cart per Day.	Coal per Day, including Lost Time.	Oil per Day.													Working expenses per Day.					
1	3	0	12	118	310	615	925	31	14 9	10 3	1 0	26 0	16 7	43 7	3 5	2 1	5 6	734	18 0	2 3	2 3	60 7	7 9	60 9	7 9	in.	770 acres arable, clay on chalk; 3-horse ploughing; coal, 14s. 8d. per ton.
2	0	4	14	56	270	240	510	9	16 0	14 4	1 0	31 4	7 8	39 0	3 6	0 10	4 4	945	23 0	2 5	61 0	6 9	..	..	..	2050 acres arable, stiff clay and stone-brush; 2 and 4-horse ploughing; coal, 20s. per ton.
3	1	0	12	81	74	184	258	34	19 6	8 7	1 7	16 8	5 8	22 4	4 9	1 7	6 4	825	34 0	6 10	46 4	13 3	..	..	..	283 acres arable, 2 and 4-horse ploughing; coal, 10s. per ton.
4	1	2	14	121	320	288	605	5	14 0	8 0	1 9	23 9	8 0	31 9	4 9	1 7	6 4	875	16 0	3 2	47 9	9 6	..	..	..	540 acres arable, 2 and 4-horse ploughing; coal, 11s. 6d. per ton.
5	0	5	14	96	463	116	578	6	13 0	14 4	1 6	28 10	4 8	33 6	4 10	0 9	5 7	945	23 0	3 8	55 6	9 3	7 to 8	7 to 8	7 to 8	450 acres arable, gravelly and stiff soil; 2 and 4-horse ploughing; coal, 16s. per ton.	
6	0	3	14	65	287	78	363	54	16 2	9 6	1 2	26 10	4 3	31 1	4 11	0 9	5 8	960	23 0	4 2	54 1	9 10	..	..	..	700 acres arable, clay on limestone; 3 and 5-horse ploughing; coal, 12s. 6d. per ton.
7	3	0	10	125	509	..	509	4	14 9	10 10	0 9	25 4	7 10	33 2	6 5	1 11	8 4	734	14 0	3 6	47 2	11 9	..	..	..	780 acres arable, rocky and clay; 3 and 4-horse ploughing; coal, 20s. per ton.
8	3	3	10	80	336	115	450	54	15 10	11 3	0 7	27 8	16 0	43 8	4 10	2 4	7 2	725	22 0	3 9	65 8	11 5	7	7	7	440 acres arable, chalk and gravel; 2-horse ploughing; coal, 20s. per ton.	
Average	1	54	124	931	331	804	554	54	14 7	10 2	1 2	25 10	6 10	34 8	4 8	1 7	6 3	844	20 0	3 7	54 8	9 10	74	74	74	746 acres arable; coal, 14s. 10d. per ton.	

* Including removals and lost time.

+ Interest (at 5 per cent.) and depreciation (at 10 per cent.) per day, spread over the days' work done in a year, with allowance for use of engine in other ways.

† Or 106 days each for machines in possession for a whole year.

SYNOPSIS OF PERFORMANCES OF FIVE OF MESSRS. HOWARD'S STEAM CULTIVATORS during the Year 1862. Calculated from Reports by the Users of the Apparatus, published in the 'Agricultural Gazette,' No. XIX., 1863.

Number of Example.	Age of Steam-cultivator at close of year 1862.	Horse-power of Engine.	Days at Work in the year 1862.	Acres Grubbed.	Acres per Day, including Lost Time.	Average Daily Expenses, including Lost Time.				Repairs and Rope per Day.	Cost per Day.	Working Expenses per Acre.	Repairs and Rope per Acre.	Cost per Acre.	Price of Apparatus.	Interest and Depreciation per Day.*	Interest and Depreciation per Acre.	Total Cost of Work per Day.	Total Cost of Work per Acre.	Depth of Work.	Size of Farm, Character of Land, and Price of Coal.
						Wages and Water-cart per Day.	Coal per Day.	Oil per Day.	Working Expenses per Day.												
1	1 0	10	77	508	£9	£20 6 9	£9 1 1	£1 1 1	£20 8 8	£9 6 8	£38 2 4	£4 9 4	£1 3 6	£4 9 1	£60 3 3	£18 16 9	£2 0 6	£57 2 9	£8 9 6	12	904 acres arable; loam; 2-horse ploughing; coal, 21s. 8d. per ton.
2	1 6	8	60	468	£7	£23 8 8	£8 0 0	£6 0 6	£32 2 12	£4 4 6	£44 6 4	£4 2 1	£1 7 5	£5 9 4	£450 16	£2 0 6	£2 0 6	£60 6 7	£7 9 6	6	520 acres arable; heavy clay; 4-horse ploughing; coal, 16s. per ton.
3	1 5	8	43	284	£9	£27 0 10	£10 0 0	£0 10 0	£37 10 9	£3 47 1	£47 1 5	£5 10 1	£1 5 7	£7 3 450	£23 3 6	£3 6	£70 1 10	£9 6	..	204 acres arable; loam; 2 and 3-horse ploughing; coal, 20s. per ton.	
4	1 4	8	103	466	£4	£16 2 7	£0 0 6	£0 6 2	£23 8 5	£4 29 2	£29 2 5	£5 3 1	£2 6 5	£5 460	£10 2 3	£2 3	£39 2 8	£8 8	..	710 acres arable; light land; 2-horse ploughing; coal, 20s. per ton.	
5	1 6	8	36	213	£6	£20 0 4	£0 0 9	£0 9 11	£24 9 11	£1 35 10	£35 10 4	£4 1 4	£1 10 5	£11 450	£28 4 8	£4 8	£33 10 10	£7 7	7	220 acres arable; loam; 2-horse ploughing; coal, 10s. per ton.	
Average	1 4	8 1	64	388	£9	£21 5 7	£7 7 0	£9 9 9	£29 9 9	£4 39 1	£40 4 10	£4 10 4	£1 5 6	£3 468	£19 3 0	£3 0	£62 2 9	£8 3	8	573 acres arable; coal, 17s. 6d. per ton.	

* Interest (at 5 per cent.) and depreciation (at 10 per cent.) per day, spread over the days' work done in a year, with allowance for use of engine in other ways.

Five Years' Progress of Steam Cultivation.

SYNOPSIS OF PERFORMANCES OF TWELVE OF MR. SMITH'S STEAM CULTIVATORS DURING THE YEAR 1862. Calculated from Reports by the Users of the Apparatus, published in the 'Agricultural Gazette,' No. XIX., 1863.

Number of Ex- amples.	Age of Steam-cult- vator at close of year 1862.	Horse-power of En- gine.	Days at Work in the year 1862.	Acres Grubbed.	Acres per Day, in- cluding Lost Time.	Average of Daily Expenses, including Lost Time.				Cost per Day.	Working Expenses per Acre.	Repairs and Rope per Acre.	Cost per Acre.	Price of Apparatus.	Interest and Depre- ciation per Day.*	Interest and De- preciation per Acre.	Total Cost of Work per Day.	Total Cost of Work per Acre.	Depth of Work.	Size of Farm, Character of Land, and Price of Coal.
						Wages and Water-car- riage per Day.	Coal per Day.	Oil per Day.	Working Ex- penses per Day.											
1	3	3	10 11 16	1075	94	25 6	6 9	0 11	23 2	4 0	5 7	6 10	5 2	503	10 0	1 0	50 0	5 6	6 to 8 in.	600 acres arable; strong loam; 3 horse ploughing; coal, 1 1/2 per ton.
2	6	6	10 42	240	54	21 9	5 0	1 0	27 9	39 1	4 10	9 4	7 2	450	22 0	3 10	61 1	11 0	..	450 acres arable; clay; 3 and 4 horse ploughing; coal, 10s per ton.
3	0	3	8 24	170	7	14 0	8 0	0 10	22 10	31 2	3 3	1 2	4 5	410	16 0	2 3	47 2	6 8	..	498 acres; clay and loam; 2 and 3 horse ploughing; coal, 1 1/2 per ton.
4	1	8	8 15	95	64	18 0	9 10	1 0	28 10	35 2	4 7	1 0	5 7	480	60 0	9 8	95 2	15 7	..	400 acres arable; strong and light; 2 & 3 horse plough- ing; coal, 2 1/2 per ton.
5	2	0	8 88	527	54	19 6	9 0	1 0	29 6	35 4	5 1	1 0	6 1	471	11 6	2 0	46 10	8 1	5 to 9	600 acres arable; heavy; 3 and 4 horse ploughing; coal, 1 1/2 per ton.
6	0	5	10 14	100	7	19 0	7 2	1 11	28 1	38 1	4 0	1 0	5 0	540	22 0	3 2	57 1	8 2	5 to 6	470 acres arable; loam; 2 horse ploughing; coal, 20s per ton.
7	3	3	10 50	323	64	14 0	7 0	0 5	21 5	31 5	3 3	1 6	4 9	540	22 0	3 4	53 5	8 1	6	165 acres arable; clay and loam; 2 & 4 horse plough- ing; coal, 1 1/2 per ton.
8	2	0	8 33	176	54	20 7	5 10	1 6	27 11	40 9	5 4	2 8	7 9	507	34 0	6 6	74 9	14 3	5 to 6	300 acres arable; heavy; clay; 4 horse ploughing; coal, 1 1/2 per ton.
9	2	5	10 52	212	4	17 0	8 5	0 6	25 11	35 1	6 6	2 3	8 9	606	38 0	7 0	63 1	15 9	9	282 acres arable; strong clay; 4 horse ploughing; coal, 20s per ton.
10	0	3	10 15	58	34	16 10	6 7	1 0	24 5	31 1	6 6	1 9	8 3	530	22 0	5 10	53 1	14 1	..	500 acres; loam; 2 and 3 horse ploughing; coal, 1 1/2 per ton.
11	0	8	10 35	174	5	20 6	8 9	1 0	30 3	41 1	6 0	2 2	8 2	550	26 0	5 2	67 1	13 4	..	520 acres; loam and clay; 2 and 3 horse ploughing; coal, 22s per ton.
12	4	6	8 52	408	74	17 6	9 0	1 0	27 6	39 0	3 8	1 6	5 3	460	19 0	2 6	58 0	7 8	4 to 10	603 acres; clay; 4 horse ploughing; coal, 1 1/2 per ton.
Average	2	3	94 454	236	64	18 8	7 7	1 0	27 3	36 2	4 7	1 7	6 2	504	25 0	4 0	61 2	10 2	64	498 acres arable; coal, 17s 6d per ton.

* Interest (at 5 per cent.) and depreciation (at 10 per cent.), spread over the days' work done in a year, with allowance for the use of engine in other ways.
+ Or 80 days each, for machines in possession a whole year.

Still, I have charged 10 per cent. per annum on the cost price for depreciation, and also 5 per cent. per annum interest on the capital invested, or 15 per cent. altogether; spreading this amount over the number of days' work, or the number of acres, done in a year—with a deduction, however, of some 20*l.* to 40*l.* for the use of the engine in thrashing and other operations of the farm. It should also be borne in mind that 1862 was not a favourable year for steam culture; so that, on some of the farms referred to, the number of days' work done was only about half of those in 1861, and consequently calculations based upon the experience of the preceding year would have brought out much lighter sums for interest and depreciation per acre.

I would remind the unfriendly critic of steam-culture that only a small proportion of my "instances" give results from newly improved sets of apparatus: lengthened experience being sought for, I have necessarily founded the calculation for "repairs and rope," as well as the daily and acreage expenses, to a large extent, upon practice with machinery far inferior in capacity and durability to that now produced by the several manufacturers in question. So that, in future, the effect of their mechanical improvements, as well as of the spread of better management in working, will be to reduce the item of "repairs and rope," and bring out a more favourable average cost per acre. The "wear" of rope itself has been a very variable figure on soft and yielding, or on stony and grinding soils; depending also upon its careful or careless mounting upon porters, and, again, upon the good or bad quality of its metal. Mr. Fowler's rope has cost, with Mr. Neames of Faversham, nearly 2*s.* per acre; with Mr. Frampton of Bensington, 1*s.*; and with Mr. G. Pocock of Bourton, only 8*d.* an acre. Messrs. Howard's rope has cost with Mr. Deane of Wallingford, 1*s.* 6*d.* per acre; with Messrs. Witcomb of Pinton, over 1*s.* 6*d.* per acre; with Mr. Cousens of Godalming, 1*s.* to 1*s.* 6*d.*; with the Duke of Marlborough, 1*s.*; and with Mr. Kay of Horsham, only 6*d.* per acre. Mr. Smith's rope has cost with Mr. Norfolk of Louth, 3*s.* per acre; with Mr. Looker of Wilton, nearly 2*s.*; with Mr. Pullen of Sutton Courtney, under 1*s.* per acre. Extravagant sums like some of these have helped to raise the general average of my tables to 1*s.* 6*d.* per acre for "rope and repairs;" but hereafter those sets of machinery which carry their rope completely clear of the earth, without involving an excessive number of rope-porters, will doubtless lower this item to about 6*d.*, instead of 1*s.* 6*d.* per acre. Let the said unfriendly critic observe, then, that a shilling an acre saved here, added to another shilling per acre probably saved (as already suggested) by a more reasonable valuation of the item of "depreciation," will make my "total cost per acre" column 2*s.* an acre too

EXAMPLES OF EXPEDITION AND CHEAPNESS WITH MR. FOWLER'S STEAM-PLOUGH.

No. of Example.	Name and Address.	Character of Land.	Horse-Power of Engine.	Work Done.	Cost per Acre for Fuel, Oil, and Wages.
1	Mr. G. Edmonds, East Leach, Gloucestershire.	Light land and stiff clay.	14	Ploughed 7 to 8 acres per day Cultivated on an average about 15 acres per day, including removals. Scarified worked land, 20 to 25 acres per day. Ploughed strong land (with heavy drag following), 10 acres in 10 hours; or, with digging breasts, 10 acres in 10 hours.	4s. to 4s. 6d. per acre; or, with repairs, interest, and depreciation, a total of 7s. 6d. to 8s. 6d. per acre. 2s. per acre; or, with repairs, interest, &c., a total of about 4s. per acre. 1s. 3d. to 1s. 7d., or a total of about 2s. 6d. to 3s. per acre. Total cost of either operation under 5s. per acre; ploughing the same acreage per day would cost 15s. per acre, and take no less than 40 horses; and the digging would be worth 40s. by hand labour. Total cost, under 3s. per acre; would cost by horses 7s. 6d. Cost (exclusive of repairs and interest, &c.), under 2s. per acre. Total cost, about 10s. 6d. per acre; value by horses, 20s. per acre; and to do the same area per day would require 30 horses. Total cost, 5s. 3d. per acre.
2	Mr. E. Ruck, Castle Hill, Cricklade, Wilts.	Heavy and medium soil.	12	Scarified with drag following, 16 acres in 10 hours. Scarified 18 acres per day on an average ..	
3	Mr. E. Holland, M.P., Dumbleton, Evesham, Worcestershire.	Clay	12	Ploughed 4 to 10 inches deep, 5 acres per day average. Cultivated 8 to 10 inches deep, 10 acres per day.	

4	Mr. E. Roberts, Berden Hall, Essex.	Heavy land ..	12	Ploughed 9, 10, or 12 inches deep, 6 acres average per day.	Total cost, about 9s. per acre; cost for the same area per day, by 24 horses, would be about 18s. per acre, and then be only 5 or 6 inches deep. 2s. 5d. per acre, without repairs, interest, &c.; for the same area per day, at least 30 horses would be requisite.
5	Mr. R. Stratton, Broad Hinton, Wilts.	Heavy land ..	12	When land is in good working order, ave- rage of ploughing is 10 acres in 10 hours.	About 5s. 6d. per acre, without repairs, interest, &c.
6	Mr. J. Arnot, Woodcote, Car- shalton, Surrey.	Light and me- dium land.	10	Ploughed, harrowed, drilled with wheat, and finished up (with assistance of 4 horses), 10 acres in 8 hours. Grubbing 6 acres, and ploughing 3 acres, or an average total of 9 acres per day.	4s. per acre, without repairs, interest, &c.
7	Mr. S. Strickland, Headley Hall, Tadcaster.	Strong limestone soil.	12	Ploughed 12 inches deep (7 inches deeper than ever before), 5 acres in 10 hours. Cultivated 12 acres in 10 hours	1s. 8d. per acre, without repairs, inter- est, &c.
8	Mr. H. Codd, Ashe, Overtown, Wilts.	Chalk soil ..	12	Ploughed 8 acres per day	3s. 3d. per acre, without repairs, inter- est, &c.
9	Mr. C. W. Goode, Chipping Nor- ton, Oxon.	.. ..	14	Cultivated 16 acres per day	1s. 8d. per acre, without repairs, inter- est, &c.
10	Mr. Owen Wallis, Overstone Grange, Northampton.	Strong clay ..	12	Scarified (with heavy drag-harrow or clod- crusher attached) 6 inches deep—184 acres in 11½ days, including shiftings. Cultivated 6 inches deep—over 22 acres in 2 days (including removal and several stoppages from trees in the field).	Cost for labour, water-cart, horse, coals, and oil, 17l. 19s. 10d.—just 1s. 10½d. per acre. Cost for labour, beer, water-cart, horse, coals, and oil, 2l. 9s., or 2s. 2½d. per acre.

The total cost has not been ascertained in all cases. According to the general average of the Table of Expenditure, about 5s. 2d. per acre should be added to the cost of fuel, oil, and wages. But that was for a performance of only 5½ acres per day: the performances in the present Table being greater, the charge for interest and depreciation must be proportionally less.

EXAMPLES OF EXPEDITION AND CHEAPNESS WITH MESSRS. HOWARD'S STEAM-CULTIVATOR.

No. & Example.	Name and Address.	Character of Land.	Horse-Power of Engine.	Work Done.	Cost per Acre of Fuel, Oil, and Wages.
1	Mr. R. Barton, Woodhurst, St. Ives, Hunts.	Heavy clay ..	8	Cultivated an average of 8 acres per day ..	About 4s. per acre, without repairs, interest, &c.
2	Mr. W. C. Morland, Lamberhurst, Hurst Green.	Stiff soil ..	8	Cultivated 9 to 14 inches deep, average about 3 acres per day.	About 8s. per acre, without repairs, interest, &c.
3	Mr. Kay, Lower Beeding, Horsham.	.. ..	8	Cultivated 9 acres in 12 hours	About 3s. 6d. per acre, without repairs, interest, &c.
4	The Duke of Marlborough, Blenheim.	.. ..	10	Cultivated 7 to 8 inches deep; average (including removals) 7 acres per day.	3s. 6d. per acre, without repairs, interest, &c.
5	Mr. W. E. Hubbard, Horham.	.. ..	10	Cultivated 6 to 9 inches deep; average (including removals) 12 acres per day.	2s. per acre, without repairs, interest, &c.
6	Mr. R. Pullen, Stockerley, Wolverhampton.	.. ..	8	Cultivated 8 inches deep; average (including removals) 13 acres per day.	1s. 7d. per acre, without repairs, interest, &c.

The total cost has not been ascertained in all cases. According to the general average of the Table of Expenditure, about 4s. 6d. per acre should be added to the cost of fuel, oil, and wages. But that was for a performance of 6½ acres per day: the performances in the present Table being greater, the charge for interest and depreciation must be proportionally less.

EXAMPLES OF EXPEDITION AND CHEAPNESS WITH MR. SMITH'S STEAM-CULTIVATOR.

No. of Example	Name and Address	Character of Land	Horse-Power of Engine.	Work Done.	Cost per Acre for Fuel, Oil, and Wages.
1	Mr. F. Sowerby, Aylesby, Lincolnshire.	.. ..	8	Cultivating (half of it "crossing") 9 acres per day.	About 3s. 6d. per acre, without repairs, interest, &c.
2	Mr. J. W. Day, Wootton.	Wold land ..	10	Cultivated, average 10 to 15 acres per day Maximum, nearly 20 acres per day	2s. 6d. to 3s. per acre, without repairs, interest, &c. About 1s. 6d. per acre, without repairs, interest, &c.
3	Mr. T. T. Ruddle, Whitsbury, Salisbury.	Light down land	8	Cultivated 10 acres in 10 hours	About 3s. per acre, without repairs, interest, &c.
4	Mr. H. Keep, Carlton, Bedford.	.. ..	8	Cultivated 8 inches deep; average, 8 acres per day.	3s. 2d. per acre, without repairs, interest, &c.
5	Mr. Morris, East Lydeard, Taunton.	.. ..	10	Cultivated 10 inches deep; average (including fixing of tackle), 7½ acres per day.	2s. 3d. per acre, without repairs, interest, &c.
6	Mr. T. Albert, Brunswick.	.. ..	8	Cultivating heavy land, average 4 to 5 acres per day. Cultivating light land, average 9 to 12 acres per day.	6s. 6d. to 8s. per acre, without repairs, interest, &c. 2s. 8d. to 3s. 6d. per acre, without repairs, interest, &c.
7	—, near Stony Stratford.	Clay soil ..	8	Cultivated 7 to 8 inches deep; average 5 acres per day.	5s. per acre, without repairs, interest, &c.
8	—, Kimbolton Park, Bedfordshire.	Clay	7	Cultivated 8 inches deep, 3½ acres per day "Crossing" 7 acres per day	7s. 9d. per acre, without repairs, interest, &c. 3s. 10d. per acre, without repairs, interest, &c.
9	Mr. S. Hutchinson, Manthorpe, Lincolnshire.	.. ..	8	Cultivated, average (including removals) about 6 acres per day.	3s. 7d. per acre; or total cost, 6s. 2d. per acre.

The total cost has not been ascertained in all cases. According to the general average of the Table of Expenditure, about 5s. 7d. per acre should be added to each sum incurred for fuel, oil, and wages. But that was for a performance of 6½ acres per day: when the performances are greater, the charge for interest and depreciation must be proportionally less.

too high. And further, as the sure effect of improvements in mechanical detail and in carrying the rope will be to increase the acreage of the daily performance, the cost per acre in the future will be still lower than even this reduction of 2s. would make it.

These tabular statistics will be more instructive as they are, than if resolved into some crude generalization of sums and quantities. Taking each synopsis by itself, the reader can compare the horse-power of engine with its acreage of ploughing and grubbing, and this, again, with the character of the soil and depth of work. He can see at a glance what great differences in daily expenditure arise from varying prices of labour and of fuel; and what a changeable item "repairs and rope" become under different circumstances and management. And he will not fail to note the wide range of "interest and depreciation" per day and per acre, as governed by the greater or less number of days' work in the year.

In comparing one table with another, that is, instituting a comparison between the performances of different inventions, it must be observed that Mr. Fowler's machine is the only one entering into the account as performing turnover ploughing. Messrs. Howard's apparatus can "plough" as well as "cultivate," but of its achievements in the open furrow I have gleaned no regular series of particulars beyond those which appear in the notice of Worcester trials. Of course had Mr. Fowler's work been all grubbing, as in the tables of Messrs. Howard's and Mr. Smith's performances, (instead of about three-fifths being the much more tedious operation of "ploughing"), his average daily acreage would have exceeded, not fallen short, of theirs. An average of many cases during this last spring, down to May 18th, furnished by Mr. Morton to the Central Farmers' Club, makes Messrs. Howard's grubbing $5\frac{1}{2}$ acres per day, Mr. Smith's grubbing $6\frac{1}{2}$ acres per day, and Mr. Fowler's work, of which only about one-sixth was ploughing, $7\frac{1}{2}$ acres per day. But the endless diversity of soils, the varying depths worked, and the fact that, either from the form of an implement or its speed of travelling, the tillage accomplished by one machine may be worth double that done by another machine, forbid our taking these tabular epitomes of experience as competitive results establishing the relative powers and expenses of rival sets of apparatus. Data from which to frame conclusions of this order are given in the details of the Worcester and other trial grounds.

From averages extending over wide areas, and influenced by exceedingly variable circumstances, let us turn to particular examples of *maxima* of daily performance, in which manufacturers' feats in the public arena are more nearly realized by the farmer in ordinary business.

I think that evidence is now coming up pretty strongly in support of two of my propositions—namely, that our existing steam-cultivators far surpass horse-implements both in *cheapness* and *quickness* of execution. Examples given show that, in some cases at any rate, a twelve-horse power steam-engine will perform a day's work equivalent to that of a force of thirty or forty draught horses; and what an advantage this must be in a pressing season—when despatch will often make the difference not simply between a full equable crop and a patchy thin one, but between a fair yield and no crop at all—let the farmer himself judge, who cannot afford to feed throughout the year anything like the number of teams that he could deal with at certain critical periods of his tilling and seeding.

The question as to relative economy and the balance-sheet between steam and animal power, in the long run, or when the whole year's work is taken into account, will appear from the next set of tables. And let it be understood that the cases here given are not picked examples, but those concerning which, whether favourable or otherwise, I have been able to get approximate details. In the tables of Messrs. Howard's cultivator (for instance) it is probable that Mr. Pike of Stevington, having displaced eight horses upon 370 acres arable, could show a better balance than appears in some of the cases given. The sums set down for total annual cost of the steam-machine are either warranted by printed statements of the parties employing it, or else founded upon estimates of competent reporters of the several cases in the agricultural press. Exceptions may be taken to my charges of 45*l.* per horse and 20*l.* per ox per annum (that is, for half the oxen kept, as these were either worked and rested on alternate days, or worked every day for only part of a year). One farmer's teams may cost him about double the expense of another's. However, the statistical averages from 21 farms, comprising 282 horses, described in Mr. Morton's paper 'On the Cost of Horse-power' (vol. xix. of this Journal), are as follows:—food, 23*l.*; blacksmiths', saddlers', farriers' bills, and depreciation (or maintenance of value unimpaired), 5*l.* 10*s.*; annual wear of implements, 3*l.* 2*s.*; share of wages of team-men, 14*l.* 8*s.*; making a total of 46*l.* per horse. Mr. Frere's valuation, in his paper on 'Steam Culture' (vol. xxi. of this Journal), is 41*l.* per horse. As to ox-teams, the systems of working and management are so exceedingly various that a general average is not easily obtained; but taking every source of expense into calculation, and allowing (in some cases) for the annual improvement instead of deterioration of the animal, I do not think my arbitrary estimate of 20*l.* per ox much too high. I am not careful to insist upon exact and proper values in these computations of annual saving
in

ANNUAL SAVING FROM DISPLACEMENT OF TEAMS BY MR. FOWLER'S STEAM PLOUGH.

No. of Example.	Name and Address of Farmer.	Size of Farm and Character of Land.	Teams formerly employed.	Teams now dispensed with.	Annual Saving of Maintenance of Teams and Implements, and of Wages of the Team-men.*	Total Annual Cost of the Steam Plough.	Annual Saving in the Cost of Tillage.
1	Mr. S. M. Plummer, Peasemore, Berks. (12-horse engine.)	740 acres arable, flinty clay on chalk; 3-horse ploughing.	30 horses ..	15 horses ..	£. 675	£. About 305	£. About 370.
2	Mr. J. W. Watts, Orlingbury ..	540 acres arable, 2 and 4-horse ploughing.	22	10	450	£. 289	£. 161
3	Mr. ———, Gloucestershire (10-horse engine.)	780 acres arable, strong clay; some light and rocky land; 2 and 5-horse ploughing.	20 horses & 30 oxen.	4 horses & 30 oxen. (Cost reckoned upon 15 oxen in continuous work.)	480	£. About 300	£. About 180.
4	Mr. E. Marjoribanks, Fawley Court, Henley-on-Thames. (10-horse engine.)	700 acres arable, chalk and gravel; 2-horse ploughing.	28 horses ..	13 horses ..	585	£. About 263	£. About 322.
5	Mr. E. Ruck, Castle Hill, Oricklade (12-horse engine.)	650 acres arable, clay and loam, 3 and 4-horse ploughing.	12 horses & 56 oxen. (All the oxen employed during a part of the year.)	56 oxen. (Cost reckoned upon 28 in continuous work.)	560	£. About 280	£. About 280.
6	Messrs. Newton and Taylor, Campfield, Woodstock.	Light land	40 horses & 16 oxen.	8 horses & 16 oxen. (Reckoned as 8 oxen in continuous work.)	520	£. About 250	£. About 270.

7	Mr. Frampton, Bennington, Walsinghamford. (10-horse engine.)	600 acres arable, 3-horse ploughing.	26 horses (And for 3 teams of oxen in winter.)	8 horses. (And with oxen, say equivalent to 3 horses.)	405	About 240	About 165.
8	Mr. J. Arnot, Little Woodcote, Carshalton, Surrey. (10-horse engine.)	610 acres arable, light loam; 2-horse ploughing; much cartage of green, &c., crops sold off.	Say 24 horses	12 horses ..	Say 540	About 280	About 260.
9	Mr. Holland, M.P., Dumbleton, Evesham. (12-horse engine.)	360 acres arable, clay, part light land; 3 and 4-horse ploughing.	16 horses ..	6 horses ..	270	About 240	About 30.
10	Mr. H. Parsons, Hazelbury, Crewkerne. (12-horse engine.)	600 acres arable, loam and stiff clay; 3 and 4-horse ploughing.	26 horses & 26 oxen.	10 horses & 14 oxen. (Reckoned as 7 oxen in continuous work.)	590	About 200	About 390.
11	Mr. E. Roberts, Berden, Essex .. (12-horse engine.)	680 acres arable; 3 and 4-horse ploughing.	22 horses ..	8 horses ..	360	About 230	About 130.
12	Mr. J. H. Langston, M.P., Sarsden, Chipping Norton. (10-horse engine.)	760 acres arable, loam and stiff clay; 3-horse ploughing.	.. ..	10 horses & 16 oxen. (Reckoned as 8 oxen in continuous work.)	610	About 250	About 360.
13	Mr. R. Stratton, Broad Hinton, Wilts (12-horse engine.)	1100 acres arable, heavy land; 3-horse ploughing.	27 horses & 20 oxen. (All the oxen worked on suitable days.)	3 horses & 20 oxen. (Reckoned as 10 oxen in continuous work.)	335	About 335	0.

* Horses at 48s. each; oxen at 20s. each.

ANNUAL SAVING OR ADDITIONAL OUTLAY from the adoption of MESSRS. HOWARD'S STEAM CULTIVATOR.

No. of Example.	Name and Address of Farmer.	Size of Farm and Character of Land.	Teams formerly employed.	Teams now dispensed with.	Annual Saving of Maintenance of Teams and Implements, and of Wages of the Team-men.*	Total Annual Cost of the Steam Cultivator.	Balance.
1	Mr. R. Barton, Wigan Farm, St. Ives .. (8-horse engine.)	520 acres arable, heavy clay; 4-horse ploughing.	27 horses	4 horses	£. 180	£. 180	£. 0.
2	Mr. J. Henderson, The Shrubbery, Sandwich. (8-horse engine.)	200 acres arable, loam; 2 and 3-horse ploughing.	12 "	4 "	180	150	30 saving.
3	Mr. J. Lancashire, Micheldever (8-horse engine.)	710 acres arable, light land; 2-horse ploughing.	18 "	3 "	165	200	35 additional.
4	Mr. R. Pullen, Shackerley, Wolverhampton. (8-horse engine.)	230 acres arable, loam; 2-horse ploughing.	10 "	2 "	90	150	60 additional.
5	Mr. W. Impey, Broomfield, Chelmsford	440 acres arable, part light, part stiff land; 2-horse ploughing.	22 "	8 "	360	About 200	£. About 160 saving.
6	Mr. Williams, North Court, Abington	.. ..	..	4 horses & 10 oxen. (Reckoned as 3 oxen in continuous work.)	280	About 212	About 78 saving.
7	The Duke of Marlborough, Blenheim .. (10-horse engine.)	650 acres arable, light land, part heavy.	22 "	10 horses	450	About 180	About 270 saving.
8	Messrs. Gillett, Highway, Maidenhead	570 acres arable, retentive loam.	25 "	9 "	405	About 190	About 215 saving.

* Horses at 45*l.* each; oxen at 90*l.* each.

ANNUAL SAVING ON ADDITIONAL OUTLAY from the adoption of Mr. SMITH'S CULTIVATOR.

No. of Example.	Name and Address of Farmer.	Size of Farm and Character of Land.	Teams formerly employed.	Teams now dispensed with.	Annual Saving of Maintenance of Teams and Implements, and Wages of the Team men.*	Total Annual Cost of the Steam Cultivator.	Balance.
1	Mr. F. Sowerby, Ayleby, Lincolnshire. (8-horse engine.)	600 acres arable, strong loam; 3-horse ploughing.	24 horses	7 horses	£. 315	£. 290	£. 25 saving.
2	Mr. C. Randall, Chadbury, Evesham .. (10-horse engine.)	540 acres arable, clay; 3 and 4-horse ploughing.	28 "	8 "	£. 360	£. About 120	£. About 240 saving.
3	-----, near Chichester	400 acres arable, strong and light; 2 and 3-horse ploughing.	13 "	0 "	0.	£. 71	£. 71 additional.
4	-----, Warwickshire	300 acres arable, heavy clay; 4-horse ploughing.	16 "	7 "	£. 315	£. 123	£. 192 saving.
5	Mr. J. S. Crawley, Hackwood, Luton ..	262 acres arable, strong clay; 4-horse ploughing.	22 "	5 "	£. 225	£. 164	£. 61 saving.
6	Mr. G. Armstrong, Graffham, St. Neots	605 acres arable, clay; 4-horse ploughing.	25 "	7 "	£. 315	£. 150	£. 165 saving.
7	Messrs. Druce, Eynsham, Oxon	900 acres arable, stiff clay and gravel.	27 horses & 22 oxen. (Half the oxen. Reckoned as worked on all 11 oxen in consecutive days.)	8 horses & 22 oxen.	£. 580	£. About 250	£. About 330 saving.
8	Mr. Bignell, Loughton, Bucks	220 acres arable, heavy land.	30 "	10 "	£. 180	£. About 80	£. About 100 saving.
9	Baron Meyer de Rothschild, M.P., Mentmore, Leighton Buzzard.	500 acres, very adhesive clay; 4 and 5-horse ploughing.	30 " (proper allowance). 16 horses	10 "	£. 450	£. About 195	£. About 255 saving.
10	Mr. Bradshaw, Knowle, Guildford ..	400 acres arable, retentive soil.	16 horses	6 "	£. 270	£. About 180	£. About 90 saving.
11	Mr. Pullen, Sutton Courtney, Abingdon (8-horse engine.)	600 acres arable, loam and clay; 2 and 3-horse ploughing.	30 "	12 "	£. 540	£. About 220	£. About 320 saving.

* Horses at 45s. each; oxen at 20s. each.

in the cost of draught tillage; because the profit of steam-culture does not consist chiefly in the cheapness of the work. While some men win a balance of several hundred pounds per annum by substituting steam for a portion of their farm-teams, other managers, more especially upon clay soils, find no material difference in their outlay since adopting the steam-plough or cultivator; and the experience of some, indeed, is that the yearly cost of their tillage is considerably increased. But even where no horses have been displaced, and the steam-cultivator has been purchased as an auxiliary power and facility entirely additional to the previous tillage force of the farm, the investment is reported as satisfactory—owing to advantages in saving of time, superior quality of work done, &c., resulting in more and better crops. Where a direct money-saving is cleared as well, the steam-plough must be earning a really handsome profit. On these points testimony shall be adduced presently. The present tables show, however, that in many cases a large saving is effected in the yearly expenditure. It will be seen that the earnings of the steam-apparatus let out on hire have not been taken into consideration. Had this been done, the pecuniary gain in many of the cases would present a much larger figure.

Enough having been advanced to prove the cheapness as well as expedition of steam-tillage, I have now to consider its *superior efficiency* in comparison with the work of the team. I need not discuss all the various elements of this superiority; as greater depth, more effectual severing and disintegration of the masses broken up or overturned, the larger extent of superficies exposed to atmospheric contact and influence, the light, untrampled state in which the shattered staple is left, the unpressed, unpoached condition of the furrow-bottom, the absence of the planting of root-weeds by horses' feet, the exposure of weeds to destruction upon the surface, or, at other seasons, their being killed by premature burial under the furrow-slice. To these numerous sources of mechanical excellence have to be added such points as the facility for drag-harrowing, clod-crushing, seam-pressing, or seed-drilling, by wire-rope traction, without the tread of a hoof, either simultaneously with the ploughing, digging, or grubbing, or as distinct and supplementary operations; and the power also of performing other processes—such as raftering, ridging for root-crops, and subsoiling or trenching two furrows deep. All these things, and more, are being practised by various farmers with the new motive-power.

The superiority of steam tillage arises also from its economy of time. A steam-plough may accomplish day by day the work of 12 to 20, or even 30 horses; in a long day it may do the work of 40 horses; so that, on pressing occasions, the farmer possesses

perhaps double the tillage force that he could afford to keep as eating-animals all the year round. He can work overtime even into the night (as some owners of steam-ploughs already do); the steam-horse does not fatigue; moonlight enables the ploughman and rope-porter boys to see what they are about, and the signals to the engineman are given by lanterns. The steam-plough ventures upon land before it is dry enough for the trampling of teams, and sometimes seeds a crop which, under horse-tillage, would not be sown at all; and what is most important of all, it sets to work after the harvest-waggon, when horses are taken up in carriage labour, yet when cleansing tillage under a scorching sun is worth double or treble what it is at any other season. Instead of dilating upon these wonderful powers and facilities which have become the truisms of the present day, I will give the opinions of some steam-ploughmen of experience. From about eighty more or less lengthened statements, which I had copied out for this purpose, I cull, out of charity to the reader, a few, exhibiting in a striking light some of the merits of steam-tillage on heavy, medium, and light lands respectively.

TESTIMONY AS TO THE VALUE OF STEAM TILLAGE.

With Mr. Fowler's Apparatus.

No. of Example.	Name and Address.	
1	Mr. E. Holland, M.P., Dumbleton, Evesham.	"The work has been accomplished in a manner in which it would have been impossible to have performed it with horses. Our heavy clays are turned over like kitchen-garden ground; and what under horse-ploughing would have taken six weeks to get over, has, under steam, occupied a fortnight. Thus we have been independent of the weather. The changes which take place in the course of cultivation are curious. After going over the heavy land two or three times, I find that less power is demanded. I am now working fields by a pressure of 55 to 60 lbs. of steam on the square inch; whereas, in the first instance, I worked at from 80 to 85 lbs. per square inch."
2	Mr. E. Ruck, Castle Hill, Cricklade.	"I consider one operation with steam-power to be equal to two by horse-power. The work done by the 'digging breasts' is preferable to any hand-labour I ever saw. Heavy land-drains very much better after steam cultivation has broken up the team-made pan. The ground works better and

No. of Example.	Name and Address.	
3	Lord. Berners, Keythorpe, Leicestershire.	quicker after rain : in fact, I have been drilling on clay land in wet weather when my neighbours could not get upon their gravelly or brashy land."
4	Mr. F. Roberts, Berden Hall, Bishop's Stortford.	"The great advantage I find to be that, when the ground is as hard as a rock, and it is impossible for any number of horses to do the work, I have with the 'diggers' burst the land up 9 and 10 inches deep."
5	The Earl of Leicester, Holkham, Norfolk.	"Though we have no furrows, our very tenacious heavy land is much drier without them than when it was ploughed by horses."
6	Mr. A. A. Young, Orlingbury, Northamptonshire.	On a strong alluvial soil lately reclaimed from the sea, "I find that one ploughing or smashing up of the stubbles, if done directly after harvest, when the land is dry, at a time when no horse-power could be employed, is quite sufficient for a spring or summer crop."
7	Mr. A. A. Young, Orlingbury, Northamptonshire.	"The 'digger' makes a summer or winter fallow at one operation; the ground is so thoroughly disintegrated that, after due exposure to the weather, all that is again wanted is one crossing with a cultivator or a heavy harrow to clean and leave it a perfect seed-bed. Compare this with the endless working of a summer-fallow under the old system."
8	Mr. Cooper, Fen Drayton, St. Ives.	"Steam-ploughing is so effectual that I consider that all work done by the end of September improves the land three times more than the cost of ploughing."
8	Mr. Marjoribanks, Fawley Court, Henley-on-Thames.	"The soil (light land upon chalk) appears very much improved in texture by the deep cultivation; and the deep ploughing and early sowing are more favourable to the wheat."
<i>With Messrs. Howard's Apparatus.</i>		
1	Mr. W. Pike, Stevington, Bedford.	"My farm (principally poor, strong, hilly, clay land) was laid up in three-yard ridges, with water-gutters drawn across the ridges to take off the water. Since I have steam-cultivated it (now more than five years) I have done away with ridges and furrows entirely; my fields are all laid on the flat, and during the wettest season I have never seen any water stand upon them. I am always forward with my work; and the few horses I now keep cost much less per

No. of Example.	Name and Address.	
2	Mr. Bray, Pyrge Park, Romford.	head than formerly, as all the hard work is done by steam. I find that by constant deep tillage, my land moves easier every year; consequently it is less expensive to cultivate." "There is no part of my farm operations gives me less trouble. To my mind it is superior to any other known system of tillage."
3	Mr. H. Collins, Duffryn, Castleton, Cardiff.	"The work of this farm was never before so forward as at this season. The cultivator is a most valuable adjunct on any farm of moderate size, whether the soil be light (as some of mine is) or heavy."
4	Messrs. Impey and Bott, Broomfield, Chalmersford.	In September, 1862, had a large extent of land already cultivated, cleaned, and banked up in drills for the manure, ready for mangel wurzel; a good deal of wheat stubble tilled and ready for spring sowing of oats and barley; and one field drilled with rye for spring keep.
5	Baron Meyer de Rothschild, M.P., Mentmore, Bucks.	The high-backed lands on the stiff clay have been levelled (mainly by the steam-cultivator), and the drains thus made about 5 feet deep; yet the deep steam tillage without trampling insures a perfect removal of water from the flat fields.

With Mr. Smith's Apparatus.

1	Mr. C. Randall, Chadbury, Evesham.	"The effect of the application of steam to the cultivation of clay land is, that the work is better done; and of greater importance still, more of it is done while dry weather lasts. Instead of the subsoil being compressed, as formerly, by the action of the horses' feet, it is now cracked by the tines of the cultivator, and the drainage thereby rendered more effective: while the autumn cultivation, which should be commenced in harvest as soon as a field is cleared, goes far to insure a crop of roots upon land where, without the aid of steam, there would be difficulty and much uncertainty in obtaining them. On light land the steam cultivator is valuable, as by its use such land is more effectually and more economically kept clean."
2	_____, near Blisworth.	"This land runs to twitch very much. I have known it in the turnips above a yard long; and I have now in my office twitch 5 feet long, dragged out of the fallow by Mr. Smith's grubber. The advantage of

No. of Example.	Name and Address.	
3	Mr. Bradshaw, Knowle, Guildford.	performing the work at the proper time can scarcely be over-estimated on stiff soils." "I am a warm advocate of 'smashing up' as against the plough. Indeed, I would never plough any land, except red clover ley. The couch upon some of my land measures $1\frac{1}{2}$ foot in length; but there is not a particle of couch now remaining upon the land which has been steam-cultivated twice."
4	Mr. T. B. Dring, Claxby, Spilsby, Lincolnshire.	Is of opinion, from much experience, that any farmer of 300 acres and upwards of deep-soil land will find it to his advantage to have a set of steam tackle <i>in addition</i> to his usual horse-power. "On light land, as well as on heavy, I find from experience that steam-cultivation is a great advantage. On such land, more liable to run to twitch than any other, if a blow be made by steam-power just after harvest on the wheat-stubbles that come in turn for turnips, it will be in a ready and safe state; but if this be omitted, and a wet spring follow, the twitch cannot be got out. The result of the twitch may be that the farmer will get a quarter of barley per acre less, and also a quarter of wheat per acre less after the seed-crop."
5	Mr. W. Smith, Woolston, Bletchley, Bucks.	"My heavy-land barley-field was cultivated and drilled at one operation, at a cost of 6s. 2d. per acre. More masterly work I never saw; the rows are as straight as lines, well connected with headland rows; short pikes as well as crooked fences were done with the greatest ease. Now let us compare this with horse-culture. A field of heavy-land barley in the neighbourhood was ploughed in that fine month February, and was drilled in an eyeable surface and raw under-surface caused by the late rains. The cost was 15s. an acre. Another field, after dead fallow, was drilled at the same time, yet the surface was cold; the cost must have been at least 3 <i>l.</i> per acre. The next, after beans, was hand-forked and ploughed twice in the autumn, in which state it lay high and dry through the winter. It was hand-forked again this spring, and drilled with barley on the same day that I cultivated and drilled mine. Its cost must have been at least 45s. per acre. The lands are all alike in character, except that mine

No. of Example.	Name and Address.	
		is most hilly and uneven; yet I am supported by my last four years' practice in expecting the produce of mine to be from one to two guineas per acre more than from either of them."

Of course the fruits of a superior tillage ought to be manifested in a larger produce. Crops should be taken that horse-culture would not have given at all, and of all there should be a greater yield per acre. And, at the same time, there should be a permanent amelioration of the soil, at least of strong land. Now, experiments in agriculture are of necessity protracted, results being seldom of value unless deduced from the repeated observations of years; and the steam-plough is too young as yet to have furnished very extensive experience through several successive harvests. Still some very important and reliable instances of augmented production and improved condition of the land are already before the world; and out of fifty good testimonies on this point, I will adduce a few specimens, premising that these are by no means more decided and satisfactory than the remainder, which considerations of type and paper compel me to withhold.

EVIDENCE AS TO INCREASE OF PRODUCE AND ENHANCED VALUE
OF THE LAND.

From Mr. Fowler's Apparatus.

No. of Example.	Name and Address.	
1	Mr. H. Codd, Ashe, Overton.	"The barley and oats after the steam-plough and grubbing are decidedly better than after the horses—at least 3 sacks per acre; also the turnips and swedes."
2	Mr. J. King, Chadhurst, Runton, Warwick.	On 300 acres arable, of mixed clay soil, some parts very tenacious, "I have been able to do away with 50 acres of dead fallow, the same being now either in crop or seeds."
3	Mr. R. Pocock, Minal Woodlands, Marlborough.	"The barley-crop this year, on land steam-ploughed last winter and crossed in spring with the cultivator, is very much better in quantity and quality than on land worked by horses, grown side by side."
4	Mr. T. Webb, Smallwood, Uttoxeter.	"I believe that it increases the value of strong land one-third, when it can be used properly."
5	Mr. Owen Wallis, Over-	"I am now feeding off a piece of very fine

No. of Example.	Name and Address.	
	stone Grange, Northampton.	common turnips, grown upon a stiff clay soil, the cultivation of which, in a season like last, I should not have attempted by horse-power. I have the fullest confidence that the land will become much lighter and more pliable, and assume altogether a different and more valuable character, especially for the production of root-crops."
6	Mr. E. Ruck, Castle Hill, Cricklade.	"The increase of Crops (after an experience of 3 years) I place at 8 bushels to the acre. I have found that the crops under the steam-plough will come a week or ten days earlier to harvest; whilst the sample is better and heavier. The crops of seeds are wonderfully better, in consequence of the extra depth of the cultivation. The increase of stock also must be very great, from extra crops of vetches and rye, and from the root-crops being of much greater weight and better quality. I am of opinion that the value of the land may be increased one-third."

From Messrs. Howard's Apparatus.

1	Mr. J. W. Pell, Stanion, Thrapstone, Northamptonshire.	"On 30 acres I have a capital crop of common turnips, and the remainder was late in the season sown with coleseed. By horse-labour I could not have prepared any portion of this for turnips."
2	Baron Meyer de Rothschild, M.P., Mentmore, Leighton Buzzard.	"Owing to the parched and sodden state of the part horse-ploughed most of the grass and nearly all the clovers perished. On the steam-cultivated portion, sound land and a full plant of both grass and clover."
3	Mr. Pike, Stevington, Bedford.	Twenty years since this farm was purchased of Earl Spencer by the Duke of Bedford for 15 <i>l</i> . per acre: now it is more than doubled in value; and it is a fact that this additional value has been gained mainly since the advent of the steam-cultivator in 1858.
4	Mr. Williams, North Court, Abingdon.	Ploughed 20 acres by steam alongside 20 acres by horses, on purpose for experiment: the produce upon the former far exceeded that upon the latter.

From Mr. Smith's Apparatus.

1	Mr. F. Sowerby, Aylesby, Grimsby, Lincolnshire.	A field on the Aylesby farm was partly cultivated by steam and partly in the ordinary way by horses. The steam-cultivated portion produced one-fourth more weight of turnips per acre than the part
---	---	---

No. of Example.	Name and Address.	
		cultivated by horses; all other things being equal.
2	Mr. J. Elliot, Tarbert Mains, Park Hill, Ross-shire.	"We had fully 2 quarters per acre of oats more after the steam-plough than after horse-ploughing; all in the same field."
3	Kimbolton Park, Beds.	"Previously to using the steam-cultivator the quality of our corn was generally 2s. per quarter below the average of the neighbourhood, and we could not get a plant of clover at all. During the last 2 years we have not only grown splendid crops of clover, but the quality of our corn has advanced 3s. per quarter, with an increase of 4 to 8 bushels per acre."
4	Mr. Bradshaw, Knowle, Guildford.	"Upon the (light) land smashed up and not ploughed, a quarter and a half more of barley was grown per acre than where the plough was used. The triumph of steam-cultivation on my farm is this: I have a piece of honest Sussex clay, which had never within the memory of man produced a crop. That clay has now produced on one side a splendid crop of swedes, and on the other side a beautiful crop of wheat."
5	Mr. Bignell, Loughton, Bucks.	A heavy soil, which, under ordinary management by horses, would be incapable of turnip cultivation. Yet of 220 acres arable, 26 acres (in 1862) were in swedes, turnips, and mangold wurzel. Part of the wheat-stubble manured in autumn and smashed up by steam-power. It was cross-cultivated by steam, thrown into 30-inch ridges by horses, farmyard dung put in the drills, and this covered in by splitting the ridges by horse-power. The result, a magnificent crop on the cheapest of fallows.
6	Mr. T. B. Dring, Claxby, Spilsby, Lincolnshire.	"I have cultivated 90 acres for wheat by steam that I should not, or could not, have done with my ordinary teams; and the result was that I got three sacks of wheat more per acre than on other land of the same quality worked with horses in a wet season."
7	Earl Howe, Gopsall, Leicestershire.	"The advantage we have upon heavy-land farms is that we can produce one-third more roots, and of course increase the number of cattle accordingly."
8	Mr. J. S. Evenden, Meopham, Kent.	(With Kentish ploughs worked by Mr. Smith's tackle.) "The sequel has been that, last harvest, the crop was doubled to any previously grown on the same field before."

It must not be concluded that because several or many steam-farmers are, by their own showing, augmenting their produce by 4 to 8 bushels of corn per acre, and largely increasing the bulk of their roots and green food, while at the same time clearing some hundreds of pounds per annum by the mere difference between the expenses of steam and animal tillage (*see Table of Annual Saving*)—that because enterprising men have wrought stubborn clays into garden-ground, from which fortunes are being realised—therefore the steam plough is everywhere to be credited with increased yields of cropping and splendid profits in all cases and upon any soil. There are numbers of examples of light and other lands where as yet no marked difference has been perceptible in the crops, and the benefits of steam tillage have been confined to facilitating operations and diminishing the general farm expenditure. The steam plough has, indeed, done wonderful things upon some—by no means upon all—strong lands that its share has pierced: on many lighter lands it has proved of signal though more moderate advantage; and there remain some sands and thin weak soils where tillage is so cheap and so comparatively unimportant a part of farm management, that the question is still open, whether steam can successfully displace there the active, quick-stepping team. These, however, are very exceptional cases: a reference to my collated instances of experience shows that the expedition and facilities of steam culture far outweigh the mere question of comparative cost per acre by steam and horses. Where a pair of horses can plough with ease a full acre per day, the small saving in cost which may be obtained by substituting steam for horse power, would scarcely warrant the venture. But having sold off teams that could plough, say 3 or 4 acres a-day, you replace them with a machine that can plough 8 or 10 acres a-day at the same depth, and that can accomplish autumn tillage more valuable than horses could perform at all.

I am a reporter of performances; not a dogmatic referee concerning the merits of rival machinery. Still, a few words are indispensable on the competing claims of *the stationary engine and of the engine moveable along the headland of a field*. Partisans of either principle are too ready to make light of serious deficiencies in their favourite apparatus, or to push minor advantages to an extreme; and hence great misapprehensions have arisen in the minds of inquirers anxious to procure that form of steam plough best suited to their particular circumstances. Neither system possesses superiority over its opponent in every point upon which you can place them in comparison; and if you deem one to have a balance of advantages over the other, the decision will have been governed by the relative importance of certain facilities or shortcomings when applied to your especial case.

Take expedition and economy in the rate of working. With the same power of engine and size of fields, the "direct" system does more work per day, and more for the money, than the "roundabout" does. For proof of which, see the facts and statistics of the Worcester and other trials. The advocates of the stationary engine admit this point against them; but contend that it is compensated for by other points in their favour. By cultivating a field without even going into it, the stationary engine leaves a moist headland unpoached by the heavy wheels of engine and water-cart. In a small inclosure, where the headland may comprise one-twentieth, or even one-tenth the area of the field, this advantage is considerable. Again, though it is not true that the moveable engine is obliged to leave the headlands unploughed, or that it is unadapted to fields of irregular figure and tortuous fences, yet the stationary engine does enjoy greater facilities for working the headlands up to the very hedges or ditches, and loses less time in adapting its rope to very varying lengths of furrow. This may be a point of some moment where a farm is choked and pestered with innumerable hedgerows; but where small fields are thrown open as they should be, and the steam plough finds several days' work in one inclosure, it is not everybody that cares to detain a powerful engine over an awkward headland, or the finishing of a "goring" corner. One Gloucestershire farmer, for instance, worked Mr. Fowler's plough in twenty fields, averaging about 30 acres each; but of the 607 acres only 548 acres were tilled, leaving 59 acres (or about one-tenth of the land) in headlands and angles to be completed by horse-power. A whole field neatly finished off may look very creditable to the steam-machine; but pushing on with work (and steam is only "an auxiliary," not a monopoliser of the tillage-labour of the farm) is often of much more consequence. However, in preparing an immediate seed-bed on a wet soil, in any other operation where horses' feet would injuriously pound and poach, or in working a combined corn-drill and cultivator, it is often a great advantage to finish-up a field completely, even at considerable delay in shifting anchors, ropes, and implements. The stationary engine cuts the best figure in these changes of direction of the work; but still the moveable engine is also perfectly able to finish-up irregularly-shaped fields: the anchorage will travel alongside any tortuous boundary; the rope accommodates itself to varying lengths of land, or has pieces added or removed, and an anchored snatch-block or two will introduce the implement into any cramp corner.

Take, now, the size of fields, as affecting the capabilities of the two systems. It is not true that the moveable engine is adapted only to large inclosures. It probably accomplishes more

acres per day, and at a less cost per acre, than the stationary engine does, whether the trial be made with short or long furrows, upon a small or an extensive plot. But it compares with the stationary engine disadvantageously in this respect: in small and irregularly-shaped fields it wastes more time if you finish-up all the ground, or else leaves an excessive proportion of the area in headlands and angles to be tilled by horses. It is not true, again, that the stationary engine can cope only with small compartments of land without removal. Mr. Pike, of Stevington, cultivates a 50-acre field, with the engine placed by a pond in one corner, having no less than 2000 yards of rope at once resting upon his porters. Mr. Sowerby, of Aylesby, has grubbed a 48-acre field, with the engine stationed in an adjoining 20-acre field, which was also cultivated (making 68 acres in all) after simply turning the engine and windlass round. And Mr. Champney, of Gatwick, Surrey, has grubbed and then cross-cultivated a 74-acre field (150 acres in all) without moving engine or windlass. Recent improvements, enabling the rope to be carried clear off the ground, have placed the stationary engine nearer upon a level with the moveable engine in dealing with large plots; but still (owing to the pulleys as well as the rope) there is a greater waste of motive power in the roundabout than in the direct system of hauling; and this limits the area which it is advisable to embrace with a stationary-engine apparatus at one "setting down." The length of rope, however, in a moveable-engine apparatus is limited only by one, not by two dimensions (by the length only, not by the breadth) of the surface tilled. Instead of encompassing all or most part of the area (as in the stationary-engine plan) the rope merely doubles the length of the furrow; and thus 800 or 1000 yards, or any given quantity of rope, might plough, with the moveable engine and anchorage, any number of acres; that is, travel with a 400 or 500 yard furrow across any number of miles' breadth of ground without one stoppage or removal. Hence the *peculiar advantage of the moveable-engine system in very extensive inclosures*. Mr. Frampton, of Bensington, has made a road through an open tract of stiff clay, from which a long furrow's work can be done on either side. The engine can travel up this road, ploughing on one side, and return ploughing on the other side, accomplishing 150 acres in all, or about four weeks' work, without any time lost in shifting apparatus. Mr. Redman, of Overtown, has a 160-acre field laid out in squares of 40 acres each, by cross driftways for the engine, which makes neat and perfect work completely up to the very edge of these roadways. Messrs. Blyth and Squier, of Stamford-le-Hope, with the permission of Mr. Cox, the proprietor, have within two years swept away the 10-acre divisions from their 400 acres arable, and laid the

entire area in one great field, apportioned into blocks or plots for steam culture. Main roads cross it at right angles; and these again are cut at various points by minor roads maintained as permanent headlands for the traversing engine. The plots are about 50 acres each; and the engine-ways are so arranged that the plots do not exceed 400 yards from headland to headland. It need hardly be said that by this spirited proceeding something like 10 acres have been added to the available tillage area of the farm. Mr. Prout, of Sawbridgeworth, on 450 acres of heavy arable land, is throwing down nearly all except boundary-hedges, filling up ditches, and dividing the farm into blocks separated by grass roads for the travelling engine, the length of furrow varying from 300 to 400 yards. There will be five of these roads, with one hard road for the main traffic, between the two homesteads. These changes will throw about 25 additional acres into cultivation. The roads, too, are supplied with five wells or reservoirs, sunk to catch the water of drainage or natural springs. Mr. Ruck of Cricklade has thrown his farm into 70-acre fields, by grubbing up five miles of hedgerows. The Earl of Leicester at Holkham, Mr. Edwards of East Leach, Mr. Williams of Baydon, and other direct-action ploughmen, have similarly provided large rectangular fields and hard headland roads.

Of course, adopters of the stationary-engine plan also find the vast importance of large straight-sided inclosures, in saving time and labour; and Baron Rothschild of Mentmore, Mr. Armstrong of Graffham, Mr. Cranfield of Buckden, Mr. Bradshaw of Knowle, Mr. Pike of Stevington, and others, might be referred to as having cleared away hedgerows and field-timber, copses and spinneys, filled up straggling water-courses, and remodelled farms and estates, to give free range to the wire-rope and shifted grappling anchors. For look at *the loss occasioned by small fields*: in the first place, from the excessive number of removals; and, in the next place, from the multiplied number of turnings of the implement at the land's end. The time occupied in a shift from one field to another may be taken as a quarter of a day, though when the distance is small the time occupied is often less than two hours. In ploughing fields of 15 acres—that is, two days' work each—a quarter of a day is sacrificed for every two full days of ploughing. If the fields be of 60 acres each, this same loss would occur only after eight days of actual work: that is to say, the loss of time by removals would be only one-fourth for the same area of work done. Throw the calculation into time or money, and it appears that it takes you three-quarters of a day longer to prepare 60 acres of seed-bed in four fields than to prepare the same area in one field; and assuming the total

expense to be 60s. a-day (time of removal being charged at the same sum as when ploughing, seeing that horses are not needed if you use a locomotive machine), *it costs you 10d. per acre more to till the same number of acres in four fields than it does if in one.* The loss by diminutive inclosures, owing to undue frequency of "turnings," is equally serious. Suppose the pace of the implement to be 3 miles per hour, or 4 chains per minute, and the time consumed in turning at the end to be half a minute; if a field be 12 chains in length, the journey occupies 3 minutes, the further time for turning amounts to a sixth of this; so that for 6 days of actual ploughing another whole day is wasted. But if the field be 24 chains in length, the journey (supposing the pace to continue the same, as a mere fraction of additional power is required for the extra length of a rope well carried) will take 6 minutes, and the half-minute for turning is only one-twelfth of this; so that for 6 days of actual work only an additional half-day will be wasted. With the implement travelling at a rate which should command 6 acres per day, you plough, with the short furrow, half an acre per day less than with the long furrow. In other words, you must spend 13 weeks in doing work that would occupy but 12 weeks, had you the longer instead of the shorter fields; and your steam culture (at 60s. per day) will consequently cost 9d. per acre more money. It seems, then, that, on a farm furnishing some hundred fair days' work in a year, 16 or 17 days more may be needed to do the same tillage, and no less a sum than 50l. per annum be saddled upon the employer of a steam plough, *solely from the excessive number of turnings and removals necessitated by small inclosures.*

I need scarcely add that this is nothing like all the loss involved. The risk of breakages of machinery is to a considerable extent proportionate to the number of signallings, stoppings, and startings in a day, and the number of journeys from one field to another; slowness and delay in the tillage and seeding become apparent in the crops; and a doubling of the proper extent of headlands eats off a considerable share from the area of perfect light tilth on the farm. Add to these considerations the thousand-and-one injuries suffered by any farmer who is hampered by the miles of weed-collecting, vermin-sheltering, crop-destroying fences with which some estates are honey-combed, and we see how reasonable it is that the steam plough, above all other implements, demands "a clear field and no favour," either to rabbits outside a warren or trees outside a wood. Steam culture is truly a valuable assistance to the farmer of medium and even light land: it is a means of insuring good profit upon many strong soils; and the consequently improved position of a tenantry, together with an amelioration of the farms

they occupy, must indirectly but certainly tend to the benefit of the landowner. Thus interest and equity alike require the proprietor to assist the tenant by those clearances and provisions which alone can develop the full advantages of steam husbandry. What share of these preparatory labours ought to fall respectively upon owner and occupier,—whether liberal covenants as well as firm roads and deep drains should be furnished gratis by the landlord, or an augmented rent be demanded for facilities that will add to the farmer's income,—depends very much upon the position of the parties concerned; seeing that while the steam plough may be a fund of profit to the tenant who is already flourishing, it may be barely a means of salvation to the man struggling for subsistence under the disadvantages of a high rent, a low corn-market, and a soil difficult to manage.

Returning to our comparison between the moveable and stationary engine systems, there are various points of advantage in one which may be considered as fairly counterbalanced by different advantages in the other. Thus, the stationary engine can frequently dispense with the labour and cost of water-carting. Mr. Martin, near Boston, always has water in ditches for the engine suction-pipe to feed by. Mr. Bradshaw, of Knowle, has dug pools and drains, supplying every station which the engine need occupy in his 30 and 40 acre fields. Against this advantage in certain situations, may be set the fewer number of removals of engine and windlass, or shiftings of rope and pulleys, required by the moveable engine plan. Both systems meet with difficulties and successes. I have seen the claw-anchors of the roundabout rope-pulleys strip through a yielding soil, and travel for yards away from the headland,—to obviate which two anchors were placed one behind the other; and the difficulty of placing anchors in some kinds of land by any reasonable amount of labour, so as to hold against a great strain, operates in such situations against the perfect tightness and carrying of the rope, except by an immoderate use of rope-porters.* Mr. Elliot, of Tarbert Mains, Rossshire, fixes stout posts in the ground at 40-yard intervals around a field, and shifts the pulley along a strong chain hung by rings to the rounded tops of each pair of posts in succession. The holes for the posts, 4 feet deep, are so few that they are dug while steam is getting

* Mr. Collinson Hall's great iron corkscrew, which is driven into the ground, may on some soils be a good substitute for the anchor. When it is to be fixed, a shovelful of earth is first taken out, and some water poured into the hole to facilitate the operation. One man then balances the screw, some 6 feet long, while another turns a lever of about the same length inserted into a ring at the screw-head. When driven home, this ring stands about 1½ feet above ground. Though the earth was dry at Worcester, the operation was quickly and easily effected.—P. H. F.

up. The Duke of Sutherland, at Trentham, is permanently inserting strong larch or oak posts in the hedgerows around his fields; the posts are 3 to 4 feet in the ground, 1 foot out, and at distances of 30 feet apart; a moveable chain of this length or a little more will be easily lifted from one brace of posts to the next, and the ploughman can hook the snatch-block in a fresh link of the chain every time the implement arrives at the headland, thus dispensing with an anchor-man. There are shallow soils upon rock which the travelling disc-anchor also penetrates and lays hold of with difficulty. Mr. Marjoribanks has chalky steep hill-side fields, where the "self-acting" anchorage has to be lashed to hedgerow trees to keep it in position.

The steam-plough "in its infancy" was greeted with the derisive monition, "gently over the stones;" but these, with other obstacles, are being skilfully surmounted. Upon the intractable Weald, with its copsewood, zigzag lanes, and awkward wooded ravines between small arable fields, Mr. Thurlow of Baysham Park, Mr. Hubbard of Beeding, and Mr. Morgan of The Thorne, employ the stationary engine with success. Mr. Morgan has thoroughly overset all the troubles and breakages occasioned by foul, rough land, filled with tree-roots. Mr. Alison, on the Hainault Farms, has worked the moveable engine in spite of breakages from land-fast roots, and with time the roots of the old forest rot and disappear. Many steam ploughmen have met with very excessive breakages from flints and other stony impediments; but the deeply-rooting powerful steam-grubber itself loosens and dislodges most of them, so that a second or third deep stirring or ploughing will have few stones to crack skifes and shares. Mr. Fowler supplies an immensely strong grubber purposely for upturning boulders (just as he supplies a mole-draining implement that drains 30 inches deep with fine effect, and will form drains even 4 feet deep, but which I have not space to describe); and Mr. Williams, of Baydon, has shown how to tear up hedges and fell trees by aid of the steam-engine. The Earl of Leicester has encountered difficulties of another kind. On soft "slob" land newly won from the tides, and utterly without roads, his engine pulled itself along over rows of faggots, and the anchors had to be weighted and blocked to prevent them from dragging.

As for hilly farms, there are undoubtedly fields to be found so steep in every direction, that no side has an inclination sufficiently moderate for the moveable engine to travel on. Here, of course, the stationary engine must be resorted to; for the wire rope will pull an implement safely and effectually not only wherever horses could draw it, but up and down slopes where no horse can find a foot-hold. But such extremely precipitous fields are com-

paratively rare; inclosures upon a hill-side have generally a top or bottom headland tolerably level, and the moveable engine is not afraid to travel and stand to work upon a moderate acclivity. Mr. Gill, of Beenham, steam-ploughs fields up and down a slope of 1 in 8, the engine and anchorage being invisible one from the other. Mr. Marjoribanks has fields varying in inclination of surface from 1 in 10 to 1 in 5; yet these are steam-ploughed by the moveable engine both up and down and across the slope, four furrows being driven at once when coming down, but only three furrows when going up.

The advantage of two moveable engines (instead of an engine and anchorage) for despatch in work, and in removing from field to field, has been referred to in the account of Worcester trials.

After discussing the relative merits of the stationary and moveable engine, perhaps I shall be expected to take up the controversy between "*turnover ploughing*" and "*smashing up without inversion*." The subject demands a whole essay to itself, and all I can offer here will be one or two general observations. The evidence already given is sufficient to show that both on clays and lighter lands, turnover ploughing and grubbing by steam-power are alike successful, and preferable to either method of tillage when effected by horse-power. For cleansing ground of root-weeds either in autumn or spring, breaking up without turning over a furrow-slice has thoroughly established itself as superior to regular ploughing; and on many strong soils (such as the calcareous clay of Woolston), a single "*smashing-up*" at the right season, or this followed by a "*crossing*" with the cultivator, proves sufficient for the destruction of the vegetable vermin. Nevertheless, there are other strong soils (such as the adhesive sand-clay of the Weald) which so quickly run together again after a deep stirring, that a single or double smashing is only the commencement of a process, and the weak couch with which the staple is infested has to be combed and combed out, and laid upon the surface, and probably collected and burned; and without these repeated cultivations, the ground would not be sufficiently aerated and fertilised. Again, there are lighter and moist loams and sands so filled with minute root-weeds, that paring and grubbing do but partially cleanse the upper half of the staple, and the plough is then indispensable to bury this and bring up the lower half for a similar eradicating ordeal. That better crops have followed from steam "*smashing*" (and more especially from using the combined cultivator and drill) than from horse ploughing, I could give plenty of evidence; that steam "*ploughing*" has furnished like results is equally well supported by facts. But the superiority of a *steam-smashed* to a *steam-ploughed* seed-bed has not been so satisfactorily deter-

mired. One thing is certain, that while on many soils a "scarified" seed-bed is all that can be wished for, on other soils a profuse crop of annual weeds upon non-inverted ground has plainly intimated the need for a mouldboard deeply and effectually to bury their myriads of seeds and germs. Let me add here that the question, What particular processes of tillage should I perform? is not at all coincident or synonymous with another question, Which particular set of apparatus should I employ? Procure the moveable or stationary engine machinery that will haul any form of implement with the greatest amount of economy, all things considered, and which is at the same time best adapted to the circumstances and requirements of your farm; and then grubbing, ploughing, ridging, rafting, subsoiling, trenching, harrowing, pressing, clod-crushing, drilling, are all within your grasp, whatever system of husbandry or philosophy of clods and tilth may be adopted or indispensable in your case.

I cannot undertake to pronounce from the evidence hitherto collected, what is the *minimum of acreage that may profitably maintain a steam plough*, or to assign such and such a horse-power of engine to so many acres of light, medium, or heavy land. Example cases, however, variable as they are, may guide intending steam-farmers in their choice.

On some clay lands, the results of steam-culture are so astonishing that a 500*l.* or 600*l.* machine has been proved to be an invaluable piece of capital on quite a small occupation. Take the Woolston farm—the first whole farm ever tilled by a steam-engine—now steam-cultivated for more than seven years, with the most carefully recorded expenses and results. Does Mr. Smith win or lose by employing an 8-horse common portable engine upon only 112 acres arable, partly stiff, cold, hilly clay—partly a gravelly clay? The year's work is as follows:—Last autumn 33 acres of wheat and barley stubble were "smashed" 10 inches deep, and 20 acres of bean stubble were cultivated and drilled with wheat at a stroke by the "combined machine;" the succeeding spring-work consisted of 22 acres cross-cultivated and drilled with beans at one operation, and 25 acres after roots "fed-on," cultivated and drilled with barley by the combined machine: altogether 100 acres worked in 19 days. The wages paid were 18*l.* 2*s.* 6*d.*; the coal burned, 7 tons (at 17*s.* 6*d.*), 6*l.* 2*s.* 6*d.*; oil, 19*s.*; the repairs and estimated wear of rope (Mr. Smith insisting upon it that there has been no perceptible wear of rope; but still for fear of under-stating the expense, putting this item at) 6*l.* 15*s.*; working expenses thus amounting to 31*l.* 19*s.* Mr. Smith considers that 10 per cent. upon first cost is a sufficient allowance for both interest and depreciation; and that only one-tenth of this ought to be charged upon his

little farm, seeing that the engine has done tenfold more thrashing and ploughing by contract for other people than it has done for Mr. Smith himself. However, he puts these items at 15*l.*, making a total yearly expenditure of 46*l.* 19*s.* for steam cultivation. If we suppose a farmer of the same area of heavy land as that of Mr. Smith to earn nothing at all by letting out his machinery, and calculate interest at 5 per cent., and depreciation at 10 per cent. (as in the tables already given), the outlay due to so small a farm will be much greater. The price of the apparatus to customers is as follows:—Engine, 230*l.*; windlass, 110*l.*; 1400 yards of steel rope, 61*l.*; two cultivators, combined drill and cultivator, and license, 108*l.*: total, 509*l.* Fifteen per cent. upon this is 76*l.* 7*s.*; and if we deduct the 6*l.* 7*s.* for the use of the engine in thrashing the farm crops, the remaining 70*l.*, added to the 46*l.* 19*s.* working expenses, makes a total yearly outlay of 116*l.* 19*s.* for steam cultivation.

What is Mr. Smith's annual saving by the displacement of teams? Six horses used to work hard to "farm his land 5 inches deep, and keep it in a rather rough state;" now he cannot half employ three horses (they labour, in fact, 43 days upon the land); and the maintenance of the three horses saved, with their implements, team-men, &c., reckoned at 45*l.*, amounts to 135*l.* per annum. The direct money profit, then, of substituting steam for horse power on 112 acres of strong land, is 88*l.* 1*s.*, if only a share of the interest and depreciation of apparatus be charged to the farm (which, of course, is most reasonable, besides being the actual fact in Mr. Smith's case), and it is 18*l.* 1*s.* if the whole burden of these items be saddled upon such a small holding.

What is the gain by increase of produce? The Woolston farm has been always open to public inspection; the magnificent crops produced each year since the commencement of the system have been viewed and reported upon by good judges, and compared with the crops of neighbouring farms. That the evidently large augmentation of yield on land now made (by only one tillage operation for each crop) as clean as a garden, has been derived from steam culture alone, has never been doubted. Mr. Smith declares that his manure consists of "straw and water;" that is, the straw grown on the farm, trodden down, and returned to the fields in a partially decomposed state; that the corn and oilcake consumed have been trivial in quantity, only two or three cows and about a dozen pigs of 160 lbs. each having been fed in the year, except the sheep eating off roots, and these have had only "a few" oats; while the three horses, being but half employed, have not required oats for a considerable portion of the year. Frequent visitors to Woolston confirm these statements in

every particular. No secrecy has been observed with respect to Mr. Smith's crops; they have been valued by hundreds of admiring visitors, and their actual yields published from time to time. Mr. Smith puts the increase, he says, "fairly" at 8 bushels of corn per acre on 56 acres, or half of the land; that is, at say 40*s.* per quarter, 112*l.* The increase of roots and clover he estimates at 30*l.*: or 142*l.* altogether. Added to the money saving by displacement of teams, we have thus a total gain of 230*l.* 1*s.* per annum, or, with the extreme charge for the whole use of the machinery, 160*l.* 1*s.* The additional capital invested in the business to create such proceeds, is as follows:—The apparatus costs (to Mr. Smith's customers) 509*l.*; and three horses, with implements, &c., being sold off at 45*l.* each, or 135*l.*, leave 374*l.* required to start the steam-cultivator. And hence it appears, that a 374*l.* mortgage on the apparatus can be swept off in a year and a half to a little over two years (according as work is or is not done for other farms beside), by working only 100 acres in 19 days per year.

The tenant is not the only party benefited (beside the labourers, who get better pay). The soil is improved, its character permanently changed; I have examined it more than once, and from the greatly increased depth and porosity of the staple and the evidences of its fertility manifested in the crops, from Dr. Voelcker's high chemical character of the ameliorated soil, and the judgment of the many practical farmers who have been to see for themselves, I can readily endorse the opinion of those who consider the fee-simple of the farm to have been raised by steam cultivation to the extent of 15*l.* per acre. Mr. Smith informs me that in consequence of the improved condition of the farm the Parochial Assessment Committee (appointed under 25th and 26th Victoria, cap. 103) have "shoved it up 10*s.* per acre over a very fair rate made sixteen years ago by a gentleman sent down by the Tithe Commissioners to value and assess the tithes of the parish, on which valuation the rate was based." Out of his profit of 230*l.* as occupier, Mr. Smith may well pay 56*l.* of raised rent to himself as landlord; and in his case it may be said that proprietor and tenant have jointly invested capital in the steam cultivator. But of course a *bonâ fide* tenant cannot be expected thus to raise the annual value of his landlord's property 10*s.* per acre, without any equivalent; and, indeed, Mr. Smith would have been utterly unable to improve his farm as he has done, had he been pestered with an undue proportion of fences and timber, eaten up with four-footed game, cramped by restrictions as to management, or without confidence or security in his tenancy. By no means let increased rental from steam ploughing be

looked for by proprietors who (like some I heard of at a Bedfordshire Agricultural Meeting) forbid their tenantry the use of a reaping-machine, out of tender love for the partridges!

The Woolston farm, though the smallest, is not the only limited occupation supporting a steam plough. My tables refer to steam cultivation upon several farms of small or very moderate extent. Among Mr. Smith's imitators, we have Mr. Tubb, of Melcomb, with a 10-horse engine, on 165 acres arable of clay and loam; Mr. Crawley, of Luton, with a 10-horse engine, on 262 acres of clay; a Warwickshire farmer, with an 8-horse engine, on 300 acres of clay and gravel; a Chichester farmer, with an 8-horse engine, on 400 acres of strong and light land. Among Messrs. Howard's customers, are Mr. Henderson, of Sandwich, with an 8-horse engine, upon 200 acres of loam; Mr. Bayley, of Romford, with a 10-horse engine, on 204 acres of medium or light soil; Mr. Pullen, of Shackerley, with an 8-horse engine, on 230 acres of loam; Mr. Pike, of Stevington, with an 8-horse engine, upon 370 acres of clay. And among Mr. Fowler's followers, we have Mr. Lawson, of Brayton, with a 12-horse engine, on 233 acres of medium and heavy land; Mr. Holland, of Dumbleton, with a 12-horse engine, on 360 acres of clay and light soil; Mr. Marjoribanks, of Fawley Court, with a 10-horse engine, on 440 acres of chalk and gravel; and Mr. Cooper of Fen Drayton, with a 14-horse engine, on 450 acres of light and heavy land.

But partnerships are quite common. A couple of farmers, being able to sell off double the number of displaced draft-horses that a single farmer could spare, find the steam plough an easy purchase, and the annual saving of maintenance of horse-teams is double what it would be for one farmer alone. Perhaps, the advantage of combination in such a purchase is greater than may be commonly imagined. Two farmers, working 16 horses each, buy say a 600*l.* apparatus, having to find 300*l.* each. The sale of 6 horses at 25*l.* per horse, produces 150*l.* for each farmer, just half his share of the purchase-money; and so 150*l.* is all the hard cash that each farmer has to find; whereas, 450*l.* would have been required, had he bought the machine by himself. And what is better still, interest and depreciation (that heavy item of 3*s.* or 4*s.* per acre) will be, in effect, only a third of this sum.

Purchasing windlass, rope, implements, and tackle, and hiring an engine to work them, is sometimes an economical plan. Mr. Bignell, of Loughton, hires a common 8-horse thrashing engine to drive his Woolston apparatus, paying an extra price per day for the privilege of being first customer when he wants to culti-

vate. Mr. Gascoigne, of Sittingbourne, and others might be mentioned as hirers of engines to drive their cultivating tackle.

Some private individuals do a great deal of work for neighbours; several companies also have tried to make a profit by travelling a steam-plough about for contract work. I have not space to discuss their proceedings and results; but the plan was not recommended by any marked success until the system of two engines amazingly shortened the time lost between one job and another, and dispensed with horses for shifting. Mr. Charles Clay's Company, at Wakefield, with one of Mr. Fowler's double-engine "sets," expended in wages, repairs, and all costs, 204*l.*, and realised 310*l.* for work done in the spring of the present year. The autumn will doubtless yield still larger earnings; and as farmers generally select their most stubborn pieces for the steam-plough, to be worked deeper than ever before, the average price of the work is taken at 10*s.* per acre. The capital of the Company, in 1*l.* shares, is now raised to 3000*l.*

To meet the exigencies of small or already burdened occupiers, the expected "Steam Cultivation Company" will be a great boon—supplying them with apparatus to be paid for by instalments extending over several years.

On larger holdings, where a considerable number of draught-animals are displaced, the outlay of 500*l.* to 900*l.* on a single piece of machinery is, after all, no very onerous matter for the farmer; no such appalling proposal as the doubling of his rent for a year. Glancing through my tables of Annual Saving, I see a 500-acre farm where 10 horses were sold off, say for 300*l.*; a 410-acre farm where 2 horses and 13 oxen were sold for 300*l.*; a 540-acre farm where 10 horses were sold for, say 300*l.*; a 600-acre farm where 12 horses were sold for, say 360*l.*; another 600-acre farm where 10 horses and 14 oxen were sold for, say 500*l.*; a 760-acre farm where 10 horses and 16 oxen were sold for, say 540*l.*; a 780-acre farm where 4 horses and 30 oxen were sold for, say 570*l.*; another farm where 10 horses and 24 oxen were sold at, say 660*l.*; and another farm where the steam plough banished 56 oxen at, say 840*l.* In several of these cases, the cash at once realised for live stock disposed of, amounted to the whole purchase money for an engine and tackle; and in the rest, went a long way towards making up the sum required.

I find that my paper, lengthy as it may seem, has left untouched several important branches of its subject. The *amount of motive power which is best for varied cases* should be well considered. Mr. Smith, of Woolston, and many other steam farmers find a profit from working common single-cylinder 8-horse thrashing engines, at 45 to 50 lbs. pressure; and even a 7-horse engine (at

45 lbs. pressure) with a 3 feet driving-sheave will work the Woolston tackle, at a proportionately slower speed. But Mr. Smith acknowledges that "10-horse engines are the best." The reasoning of other persons also is very sound,—that when you have a system of anchorage that will stand the strain, it is much better to plough 8 acres a day than only 4, for the same number of hands engaged; and though clay farmers in Kent and elsewhere may be content with a steam apparatus that will turn over 3 acres a day 8 inches deep, because of the extraordinary value of the tillage on such soil,—yet in a vast many other cases, cheapness and expedition are of especial importance: on some light lands, indeed, constituting almost all the advantage of steam over animal culture. Here the limit of the power of the engine seems fixed only by considerations of first cost, and the practicability or inconvenience of an enormous weight in a country of steep gradients or of soft fields and unsound roadways. Some purchasers of apparatus have exchanged their engines for others of higher power; even on a moderate-sized light-land farm, we have one employer expressing (in a testimonial to the manufacturer) his regret that he had not bought a 14-horse engine at first. And some of those who adopted the steam grubber at first, simply as an autumn-cleansing auxiliary fitted to the old thrashing-engine, have procured a stronger steam-horse, extended the wire-rope over the more general tillage of the land, and proceeded to work the turn-over plough where it was requisite.

Another point which I cannot dwell upon, but which might occupy a large space in an essay on new systems of husbandry introduced by the steam-plough, and on the whole economy of steam farming, is the management of labour, and the good effect of variously arranged piecework in quickening that with which the enraged metropolitan sweep upbraided his ass—the "agricultural pace."

Long Sutton, Lincolnshire, July, 1863.

XXIII.—*On the Development and Action of the Roots of Agricultural Plants at various stages of their Growth.* By the Rev. M. J. BERKELEY, M.A., F.L.S.

SINCE the publication of Sir Humphry Davy's work on Agricultural Chemistry, in 1813, no treatise has perhaps had so great an influence on the progress of really scientific agriculture as Baron Liebig's *Letters on Chemistry and Modern Agriculture*. Many of his conclusions have, indeed, been strongly contested, and his observations are often fanciful, if not incorrect; but even in those

portions which are most open to criticism, he is always suggestive, and can scarcely be read carefully without profit.

His work on the *Natural Laws of Husbandry*, which has just been published, as edited by Dr. Blyth of the Queen's College, Cork, gives the author's mature views on agriculture after sixteen years of experiment and reflection. The observations made above apply equally to this as to his former publications. It is almost impossible to read it without having, at every step, something of a mental conflict with the author; and it is hard to receive many of his passing remarks, without some doubtful misgivings and wish to test their accuracy. Still the impression on the whole is one of thankfulness to the author for opening so many curious and interesting matters of research, accompanied by a hearty desire for personal confirmation of his statements.

Liebig's theory that the food of plants consists of inorganic matters, and that every one of the elements of food must be present in a soil for the proper growth of a plant, is, as the editor remarks in his preface, the basis of the work. The position is doubtless to a great extent true; but though glutinous or, as they are sometimes called, colloid matters will not readily enter the spongelets, if at all, it is far from certain that all organic matters are rigidly excluded, as it is that everything which goes to the support of a plant enters by the roots exclusively. Still the editor's position in the following passage will be generally received as incontrovertible:—"The discovery of the remarkable power of absorption possessed by arable soils has necessarily led to a modification of the view regarding the mode in which plants take up their food from the soil. As the food of plants cannot exist for any length of time in solution in soils, it is clear that there cannot be a circulation of such solution towards the roots, but the latter must go in search of food. Hence the great importance of studying the ramification of the roots of plants cultivated by man."

The first chapter of Liebig's new book is, amongst other matters, devoted to this subject, to which the following pages are dedicated, without, however, professing to be an abstract or review, though availing themselves everywhere of the rich storehouse of facts therein contained.

Plants have often been justly described, in general terms, as animals turned inside out, the leaves representing the expanded lungs, and the roots, with all their ramifications, the absorbents of the intestines. The analogy, of course, is not very complete; but it is partially applicable to two important sets of organs which in all questions of vegetable physiology must hold a primary place. It is to the latter almost exclusively that attention will be drawn in the present memoir.

If we look at the condition in which food is taken up by the absorbents, at least in the greater portion of the animal kingdom, it is at once apparent that in one respect the analogy fails. Whatever choice the spongelets may exercise in the absorption of nutritious matter; whatever be the connection of the soil with the fluid holding plant-food in solution; and whatever the possibility of minute, and especially nascent, particles not in solution being taken up; elaboration is an after process.

The roots of plants may conveniently be considered in three distinct stages of growth, viz., in their primary development, their stage of ramification, and their enlargement or differentiation as receptacles of nutriment for future exigencies.

We have then to consider first, the very earliest stage of their existence, while still within the seed, or only just bursting through the envelopes. It is remarkable, that in phænogamous plants the root-end of the embryo is always in the first instance turned to the little aperture or micropyle through which the pollen tube enters and comes in contact with the embryo-sac, and so effects impregnation, though as the ovule grows it often takes a different direction. In those cryptogams, as ferns and club-mosses, which come the nearest to phænogams, exactly the contrary position of the embryo is maintained. This fact seems to indicate that even in this very early stage of growth, the radicular extremity has some important function above that of the cotyledons.

The embryo, consisting of one or more cotyledons, the spongelet, and the intermediate portion between that and the plumule, composed of the neck and true radicle, is either quite free within the coats of the seed, or is surrounded by a greater or less quantity of tissue, known by the general name of albumen, though the word does not bear the same import as it does in chemistry. This mass abounds in starch, and often in oil globules or other matters more or less easily convertible, while the coats are sometimes rich in gluten or other important substances. The spongelet, which is the active part of the radicle, consists of a mass of naked cells, more or less intimately connected with each other, and with more or less definite intercellular passages, which have, however, no communication with each other except through the walls of the adjacent cells.

Since the time of Richard, botanists have divided phænogams into two principal groups, endorhizal and exorhizal; or those whose primary root is internal, and on germination bursts through the surrounding tissue, and those whose absorbent surface is absolutely naked. I have, however, long been of opinion that this distinction is not tenable, and depends more upon the peculiar structure of the embryo in cereals, than upon that of mono-

cotyledons in general. If the germination of many plants of this great tribe is traced from the commencement, it will be found that the primary root is as truly naked as in any dicotyledon. I have studied the germination with an especial view to this subject in the following plants:—*Asphodelus luteus*, *Uropetalum serotinum*, *Sisyrinchium iridifolium*, *Colchicum autumnale*, *Iris Sibirica*, *Allium cepa*, *Zephyranthes candida*, *Bulbine annua*, *Trichonema pudicum*, *Asphodelus ramosus*, *Arum maculatum*, *Ixia stellata*, and *Babiana plicata*; and in all of these the primary radicle is most certainly exposed, and does not burst through any part of the embryo. The embryo of a cocoa-nut is on a considerable scale; and it will be seen at once, on examination, that the primary root is naked.

If, however, we examine the germination of cereals, such as barley, things at first seem to be quite different. The first root which penetrates the soil, which by the maltsters is called the acrospire, certainly bursts through the surrounding tissues, just like the secondary and adventitious roots of phænogams in general. This root is not however always solitary; but, like other secondary roots, may be protruded in company with others. How then are we to explain this? I believe the truth to be, that the real primary rootlet is the little shield-like body or scutellum which is in contact with the albumen, and which imbibes nutriment from it so long as it is needed, or rather till the secondary roots have sufficient strength to support the plant. This was Richard's view; but it has not obtained favour with botanists in general. If, however, this view be correct, the anomaly ceases except so far as the functions of the primary rootlet are concerned, which are to derive support from the albumen and not from the soil. Whether, however, this view be considered correct or not, it still remains quite certain that, in a large portion of the plants which pass under the name of endorhizal, the primary root is not internal, but is prepared at once to perform its functions, so soon as matters are ready for germination,—a point apparently of immense consequence to success. The spongelet is probably the very first part which imbibes nutriment, and thus favours the elongation of the radicle.

It is needless to carry this discussion further, though it is far from being irrelevant to the subject before us. If what I have stated is correct, it may be announced as a general rule, that the absorbent extremity of the radicle is external, and ready at once to imbibe the needful nutriment when placed in circumstances favourable to germination.

A certain temperature, air, and water, are absolutely necessary for this purpose; and in many cases these are sufficient, at least

for the infant growth.* In those cases in which there is no albumen whatever, some little soluble matter may be derived from the integuments which may conduce to the change from a state of perfect rest to one of active growth; and by means of this, chemical change may take place in matters stored up in the cotyledons themselves, which may aid in the primary development of the embryo.

Supposing, then, moisture, warmth, and air to be ready in their proper measure, the water is absorbed by the integuments, from thence by the albumen if present, and finally by the substance of the embryo. The water converts soluble fibrine into diastase, which in its turn acts upon the starch, converting it into sugar, which is also supplied by the oil globules, which are sometimes abundant, while other portions are converted into dextrine, and the cellulose itself undergoes chemical changes which in the end tend to the evolution of the embryo, or to its nourishment during the early stages of growth; and sometimes one nitrogenous matter acts upon another, and so induces change. The oxygen of the air which is in contact with the seed combines with part of the carbon, and carbonic acid is evolved, and at the same time a notable quantity of acetic acid. In fact, the seed is a miniature laboratory, in which numerous chemical actions are taking place, many of which would defy our powers of manipulation.

Where these conditions are not combined, either germination is suspended, or the seed finally rots or withers. Each seed has its own range of temperature, within which alone germination can take place, and a limited period beyond which its vitality cannot be preserved. Carefully conducted experiments do not confirm the marvellous accounts which are from time to time brought forward respecting the suspension of germination for many centuries. Such accurate observers as the late Professor Henslow, without any proclivity to the marvellous, have effectually dissipated numerous histories in this direction which have too unguardedly been received as true.

As the radicle is the first to break its bonds, it will be nourished after a short time directly from matters either traversing the pores of the soil, or combined with it, and will profit only indirectly by any nutritive matter which may yet remain in the albumen or cotyledons, its own efforts being now indeed mainly

* Plants grown in pure water without any addition to it of mineral substances acquire no increase in weight beyond that of the seed from whence they are derived, and can bring no fruit to perfection, even if they form flowers. It appears from Boussingault's experiments, that where mineral substances are excluded, the organs will absorb water, but neither carbonic acid nor ammonia; or at least, even though they be introduced into the plant by means of the water, they exert no influence upon the internal process: they suffer no decomposition, and no vegetable matter is formed from their element.—*Liebig*, l. c. p. 44.

directed to the development of the plumule, or to the production of ramifications from itself with the same ultimate view. A constant interchange indeed is going on between the cells of the whole plant, so that no part is perfectly independent of the other. In the case of cereals, where the first rootlet which enters the soil has to force its way through the surrounding integuments, a very important supply is made through the scutellum, which remains in contact with the albumen till the whole of the nutritive matter is exhausted.

So important, however, to the welfare of the plant is the accession of new matter, which can be obtained only from the soil, even in the earliest stage of growth, that before any secondary rootlet is produced, the young radicle in many cases pushes out from its superficial cells a forest of delicate hairs, every one of which is employed actively in absorption. As far as I have seen, the radicle is at first perfectly smooth, as, for example, in the common onion; but in general this condition does not continue long; and I have sketches of germinating seeds of several of the plants above mentioned, in which hairs were abundant shortly after germination. Sometimes these hairs do not appear at first upon the true radicle, but form a little coronet at its junction with the neck,* as in *Iris sibirica*. In some plants the connexion between the embryo and the seed is of very long continuance, as in palms. The onion, however, affords a familiar example. The tip of the cotyledon is inclosed for a long time within the albumen, remaining bleached, and doubtless capable of absorption by its delicate surface. It will be observed, moreover, that if a speck of paint or ink is placed at the bend of the loop, which is made by the primary cotyledon on germination, the two parts increase in length, independently of each other, except so far as there may be an interchange of nutritious matter, the position of the speck remaining to the last unaltered.†

It is clear from what is stated above, that it must be of great importance in the cultivation of cereals to have good sound seed. The first object is to ensure a quick and vigorous germination, which will scarcely be the case with thin, meagre seed derived from mildewed plants. No worse economy can be practised than that of saving a few shillings in the price of seed-corn. The germination will not only be comparatively slow, especially in ungenial weather, but the weak plant will fall a sacrifice to slugs and other vermin, if it does not assume, which

* It is usual to call the whole of the axis below the plumule "radicle;" but there is often a marked difference between the true radicle and the portion of the axis from whence it is given off, called by authors the neck or collum. This is an important matter in sugar-beet, as in that plant at least it contains little or no sugar.

† This curious matter was first observed by Richard, who published a memoir on it in the *Annals of the Museum of Natural History at Paris*

will often be the case, a pale and chlorotic appearance, from which it will never recover, even if the land itself is in good heart, which is not likely to be the case where the price of seed-corn is stinted.

While, however, the first exigencies of the young plant depend upon the proper supply of nitrogenous and amyloid or starchy matter contained in the seed, it must never be forgotten that this supply lasts for a short time only, and that the ultimate vigour of the plant must depend upon the intrinsic condition of the soil. Many a crop which looks vigorous enough on its first appearance soon wears a sorry aspect where the soil is ungenial and its condition mean.

An objection, however, has been made to me by a practical farmer to the following effect. Most of the objects of cultivation are in a condition which is not natural and is therefore akin to disease—a condition which constitutes their merit as objects of cultivation. It is thin, starveling seeds which in wall-flowers and dahlias produce the best flowers. It is, besides, a well known fact, that to produce first-rate turnip-seed, which will yield good roots without running too much to leaf or stem, the turnips must be transplanted and not allowed to flower without removal. The size of the grains in our best wheats is as unnatural as that of the turnip, why then should we object to the use of thin, meagre seed?

There is doubtless something in the objection; but though seed-wheat, if sound and healthy, is better when derived from a poorer soil than from one which is highly manured, we have no right to expect good results where the seed is in so mean a condition that it cannot properly supply the first necessities of the plant. Seed from well-cultivated soil, where artificial manure is not too freely used, is far more likely to produce a good yield than that from highly pampered plants, which, like those from new melon or cucumber seeds, will be apt to run to leaf. There is little doubt that much remains to be done for the farmer in this direction.*

I have hitherto considered only the first stage of the root, nourished at first by something derived from its envelopes, then

* Diseased conditions are often handed down by seed. A few years since I had some diseased oats submitted to me, which were taken from a particular part of a field. I found on inquiry that the seed used in this part of the field was derived from a different quarter—a matter which I had suspected from the first. The seed produced year by year was sown by me several years in succession, and the peculiar bleached appearance of the bells was constantly reproduced. I have no doubt that seed from a healthy crop is of great importance; and it is much to be wished that cultivators of known integrity and intellect should turn their attention to the production of seed-corn as a special branch of agriculture, a practice which would prove, I believe, highly remunerative. See '*Agr. Gaz.*' 1855, pp. 569, 586.

partly by what is contained in the soil and partly through the medium of the cotyledons, whether remaining or not in contact with the albumen, and then in order to produce as extensive an absorbing surface as possible, giving off in a multitude of instances numerous delicate absorbent hairs.

The next stage is to produce from the axis, either above or below the plumule, secondary or adventitious roots, which either remain simple or ramify in every direction. The tips of these processes, which consist always of naked spongy tissue, not covered with cuticle, are certainly in many, if not in most, cases the only parts capable of absorbing nutriment from the soil, always excepting the delicate threads above mentioned, which are produced also from the surface of the roots at various periods of growth, sometimes even in the third stage, which will be considered presently. Even supposing that in the first instance, as the radicle elongates, the surface has some absorbent power, the walls of the cells become frequently so hardened and thickened with corky matter, besides being clogged up with colloid or gummy substances, that they seem rather destined to protect the subjacent tissues from injury, than as absorbents; while, on the contrary, the tissue of the spongelet is constantly renewed, the old effete cells being rejected backwards so as to invest the cuticle.

In their earliest stage of growth, whether normal or adventitious, roots consist of a little convex body composed of apparently homogeneous cells resting upon the elongated cells of which the greater part of the woody tissue is composed, and more or less converging at the apex. The outer cells at the apex soon, however, become distinct or separated from the rest of the mass all round, so as to form a little close-fitting or loose cap attached only in the centre. The whole gradually forces its way through the bark or outer coat, either turning aside the tissue or absorbing it, so as ultimately to become free, the spongy cap still adhering and forming the principal, or at least the most permanent, part by which nutritive matter is imbibed. As the young roots are in immediate connexion with the albumen, from which their central tissue is directly derived, and the spongy mass rests on the tip of the cone of elongated cells, it is evident that the matter imbibed by the roots is at once conveyed to the very part of the plant where the upward current is most active.*

As the tissue of the spongelet is very delicate, and easily assumes the form of anything against which it presses, it can

* This paragraph is taken, with slight alteration, from Sections 46 and 50 of my series of papers on Vegetable Pathology in the 'Gardener's Chronicle.'

come into intimate contact with the soil, and penetrate through any crevice, however narrow, in a rock or drain-pipe in search of nutriment.

We are not to suppose that fluid enters into the spongelet by mere endosmose,* though from the strong demands for fresh supplies constantly made by evaporation from the leaves, the admission is comparatively easy, without any active exosmose. This agency would be, perhaps, sufficient to account for the rapid admission of fluid after a season of extreme drought; but in dry weather, when there is little moisture in the soil, or in extremely wet weather when there is little or no evaporation, vital energy must be taken into account in order to have some notion of what takes place.

The most important question, perhaps, which arises in considering the relation of the roots to agriculture, is what power they have in the selection of food. That they have some is apparent from the fact that different plants in the same soil will appropriate different proportions of chemical matters, and that some exhaust more rapidly than others particular constituents. Wheat and peas appropriate very different proportions of silica; *Tamarisk* and *Salsola* in the same ground give very different chemical results, the former containing more magnesia and the latter more soda; while in *Eryngium maritimum*, which grows exclusively on the sand which borders the sea, and is strongly impregnated with chlorate of soda, there occurs three times as much potash as soda. *Lycopodia*, with some other cryptogams, are remarkable amongst plants for largely appropriating alumina. But more than this, some plants have the property of appropriating enormous quantities of some especial element, when it exists in infinitesimal quantities in the surrounding medium. The quantity of iodine in sea-water is so small as scarcely to be detected except from the highly concentrated fluid, and yet several marine plants contain great quantities. "The ash of *Viola calaminaria*, according to Alexander Braun, a plant which, in the parts about Aix-la-Chapelle, is held so strongly indicative of the presence of zinc, that the places where it grows are selected for opening new mines in search of zinc-ore, is found to contain oxide of zinc," a substance which few plants could appropriate.† Great, indeed, as are the powers of vitality in effecting chemical change, we have

* The words endosmose and exosmose are used to express the mutual action between two fluids of different specific gravities on different sides of a thin membrane, by means of which the one enters (by endosmose) and the other exudes (by exosmose). Gaseous bodies enter and are given out in like manner; and when different gases are mixed together, they have different rates of penetration, one being admitted more rapidly than another. A familiar instance is afforded by the process of oxygenating and decarbonizing the blood in animals.

† Liebig, * Natural Laws of Husbandry,' p. 67.

no evidence to show that they are capable of generating bodies which at present defy the power of analysis. If potassium, sodium, calcium, and other elementary bodies, therefore, exist in plants in greater quantities than could be contained in a bulk of the surrounding fluid equal to that which traverses the tissue in a given time, these must have some especial power of abstracting it from without. One of the most curious instances on record is that afforded by the ash contents of certain parasites, as misletoe, compared with those of the plants on which they grow, though they draw their nourishment from sap already partially elaborated. Where the quantity is less than might be expected, it becomes a question whether roots have not some power of getting rid of superfluous matter, a subject which we shall come to presently.

It is well known that soils have great power of absorbing into their substance, or, at least, of attracting, different matters which pass through them, as nitrogen by clay, and that in so stable a form that water passing through the mass, even when strongly impregnated with carbonic acid, will not extract them, though under certain conditions the various salts are slowly soluble. Schleiden some years since endeavoured to show that the only use of vegetable soil was to serve as a storehouse for nutritive matters,—an extreme view which will not very readily meet with general acceptance. Some authors regard the spongelets as acting by mere mechanical or chemical rules, without allowing any especial power to them as endowed with life. According to this view, matters enter them precisely in the same manner as if the walls of the component cells consisted of mere dead membranes, and their contents were a mere chemical solution. It is clear, however, that something far removed from any form of capillarity must be at work, and though something may be attributed to the different rates of penetration of different substances when mixed together, and not in chemical combination, it seems impossible to deny the existence of some higher power, which, for the want of anything more definite, may well pass under the name of vital energy, or vitality. Without attaching any mysterious notion to the term life, we cannot be wrong in using it merely as an expression for those phenomena which take place in living organisms, but which would never take place in mere mechanical apparatus, and which cannot be imitated by artificial methods at present known. I say at present known, because it is impossible to predict what may be effected by modern chemistry. One step at least has been made in the production of a substance like alcohol from inorganic materials, hitherto supposed to require organic matter for its formation.

It is, however, time to consider the excrementitious powers of roots; for if they have the means of getting rid of any excess of

salts, it might possibly be the case that though one plant appropriates less than another, it may really have imbibed as much, as it has means of getting rid of the excess; and this would apply to tree parasites as well as to other plants.

On this, as on most other questions of vegetable physiology, diametrically opposite opinions have been current, some attributing the deterioration of land for especial crops as much to the poisoning of it from excretions as from the consumption of its nutriment.

The matter has lately been studied by Cauvet, an abstract of whose memoir I have given in the 'Gardener's Chronicle' for Feb. 14, 1863. His observations agree very closely with those contained in a lecture on Agricultural Chemistry by Dr. Daubeny, which is reproduced in the agricultural portion of the same journal for Dec. 14, 1861, every sentence of which may be read with profit.

Most previous experiments had been made with plants more or less injured, if not by actual division, for the purpose of inserting different portions of the plant in different fluids, at least by the destruction of the spongelets, the only active parts, due to the removal of the plant from the earth, or the mere act of washing away the adherent soil, which could scarcely be effected without more or less impairing such delicate organs. To avoid this evil, M. Cauvet caused seeds to germinate on a wooden frame pierced with holes, so that after they had germinated, they could readily be lifted up for inspection, without injury, from any fluid in which they might be immersed. Now it appeared, first, that fluids in which colouring matters are merely suspended were wholly unfit for the purpose, as they would not enter into the tissues. If matters were employed which were really soluble in water,—whether active, as solutions of minerals—or inactive, as the juice of phytolacca berries,—they were received only partially into the system, so long as the spongelets were physiologically sound, though they affected their cells and the more superficial parts. The former substances at once destroyed the spongelets, and if admitted at all were admitted by mere capillarity; while the colouring matter of those of the second class was deposited in a glutinous form round the cells, rendering the admission of any fluid difficult. In the former case the noxious matter entered by means of the fibro-vascular system, a circumstance of immense importance as regards those diseased conditions of plants in which the first symptoms of decay are the deposition of dark matter, consisting probably of ulmates and humates, in the vascular tissue, as is so frequently the case in turnip rot. The same appearance is not uncommon in the potato disease; but as we

have to do there with underground stems and not with true roots, the evil is of more remote origin.

It is well known that both vegetable and mineral poisons are destructive to phænogamic plants. How, then, do the poisons act? Roots physiologically sound do not absorb indifferently all substances which are soluble in water or which may be incorporated with the soil in a minute state of division. The experiment may be easily tried with arsenious acid, and there is the more reason to repeat the experiment, as published accounts are very conflicting. The truth seems to be that if the dose is only small, it is not absorbed; if large, the spongelets are destroyed, and a portion enters but only a short way up. The plant is then destroyed at once, or if some of the upper roots remain sound, the poison is eliminated partly from the leaves which fade precisely according to their order of development, and partly together with the water of evaporation. In such cases the plant in the end is not affected, and ultimately no poison can be detected by the closest analysis. Dr. Daubeny made experiments also with strontian and barytes, which do not normally exist in plants; and, as in the case of arsenic, he found on analysis no trace of these substances where plants arrived at perfection: showing clearly that either the roots had some power of refusing substances which were not necessary, or might prove injurious, or that if a portion was admitted, it was somehow or other eliminated. Some metallic salts, exclusive of such matters as potash and soda, however, do not seem so difficult of access. Iron, at least, seems essential to many plants, and it is occasionally found on analysis, as in beechwood or tree-lichens, where it does not normally form a constituent.

"The power of roots," says Liebig, "to preclude the passing of certain substances from the soil into the plant is not absolute. Forchhammer (Poggend. Annal., xcv. 90) detected exceedingly minute traces of lead, zinc, and copper in the wood of the beech, birch, and fir, and tin, lead, and zinc in that of the oak; but the fact that the outer rind or bark in particular is found to contain metals of this kind in perceptibly larger quantities than the wood, clearly points to the accidental nature of their presence, and to their taking no essential part in the vital processes of the plant." The copper which is often found in wheat on analysis is evidently derived from the sulphate of copper with which seed-wheat is dressed to prevent bunt.

It now becomes a question how far any elimination can take place by the roots, a most important matter as regards the theory of cropping. M. Cauvet accordingly directed especial attention to this point, and the result of numerous experiments is entirely

against any excretion from the roots. Foreign matters, whether actively destructive to the spongelets or not, if once admitted in quantity, soon produced death; and if in consequence of new roots being thrown out the plant survived, the peccant matter was in no case thrown off by them.

Fibrous roots have sometimes enormous power of penetration in search of nutriment,—a property which becomes a serious evil if the subsoil does not contain the proper salts which are needful for the especial exigencies of the plant, or in proper proportions, or if they meet with matter absolutely noxious. In the orchard many a fruit-tree thrives so long as the roots are superficial; but when they penetrate deeper, nutriment either insufficient or of an improper character is received, vitality is impaired, and various forms of canker or chlorosis are the consequence. To some plants lime is a positive poison, and for this reason rhododendrons will not succeed in a limestone district.*

Sometimes the evil is of a different character. In such crops as sugar-beet, which is often grown for several years in succession on the same ground, where the roots penetrate deeply, a portion is always left behind when they are lifted, and so soon as the tap-root of the next year comes in contact with the old decaying portion, it is contaminated, the leaves in consequence flag, and the whole plant ultimately becomes unhealthy.†

Another evil attendant on the elongation of roots arises from their penetration into drainage tiles, sometimes completely blocking them up, and rendering them useless. Willow and elm roots often act in this way; but herbaceous plants are scarcely less mischievous. Even grasses will sometimes clog the drain tiles up, and I have seen an instance where the fibres of mangold have attained in such a situation a length of some feet. A case lately occurred in which the common *Equisetum* of ploughed land, or Besom-weed, ‡ was the cause of mischief.

Another evil arising from deep penetration, where there is stagnant water, is the depression of temperature, which is highly injurious. Every cultivator is aware of the benefit of bottom-heat within certain limits, and where the ground is deep and uniform, as in the best cotton and tobacco grounds, the rootlets may find exactly that degree of temperature which is most congenial to them. In cold countries, where the surface is frozen

* This is singularly evidenced within the space of three or four miles in Denbighshire. At Coed Coch rhododendrons are a weed, the district being Silurian. At Gwrwch Castle no pains have succeeded in establishing them, because the district is one of carboniferous limestone.

† 'Des Maladies de la Pomme de Terre de la Betterave,' &c. Par A. Payen. 'Bibliothèque des Chemins de Fer.'

‡ In some districts this name is applied to species of *Anthemis* and *Matricaria*, and allied genera of chamomiles.

for great part of the year, vitality will be sustained by temperature derived from the deep-seated rootlets.

In wheat-cultivation the great object is to multiply the lateral rootlets as much as possible, that they may avail themselves of the more abundant nutriment towards the surface of the soil. One great end obtained by pressing the ground in light soils before the sowing of wheat is the encouragement of laterals. It is true that wheat will sometimes penetrate to a great depth, but seldom perhaps with advantage.

We now come to the third stage, in which roots or portions of them become reservoirs of nutriment for future use. Roots vary considerably in their character: some penetrate deeply, remaining fibrous and delicate to the end; some throw out numerous laterals, and affect the surface of the soil; some merely yield the necessary daily nutriment; while others, under various guises, as asparagus, turnips, carrots, &c., devote certain of their parts or ramifications to the especial office of storing up starch, pectine, bassorine, and other nutritive matters, sometimes in enormous quantities and with extraordinary rapidity.

We must not, however, suppose that all underground parts which serve as storehouses belong to the same category. The bulb of the onion, the corm of the saffron, the tubers of potatoes, though answering the same end, are either furnished by the base of the leaves or are underground stems. The trunks of trees themselves are also in many cases receptacles of nutritive matter, of which the sago-palm is a well-known example, and the lime, abounding in mucilage, one nearer at home. In a great variety of plants, moreover, the pith supplies a large, though temporary, supply of nutriment. The cells, however, for the most part, are soon exhausted, and become mere bags of air. Sometimes there is a double store of nutriment, as in some species of crocus, both in the corm and thickened roots.

It would be wrong, however, to suppose that the proper function of roots in general is that of storehouses. Their office is rather to convey fluids which, either in their course through the roots themselves, or the stem with its ramifications, or finally the leaves and bark after various elaboration, deposit various matters which are either set aside as of no further use, or where they can do no harm, as the crystals which are so abundant in many plants, or stored up carefully to serve some ulterior end.

In some plants, like carrots and turnips, the main object seems to be the deposit of nutriment for the perfection of the seed in the ensuing year; while in the case of perennials, either a special part is devoted to this purpose, as in many orchids, whose place when it has become effete is supplied by a new growth, or the supply is generally distributed and used as occa-

sion requires (*pro re natâ*). In fruit-trees it is quite certain that the deposit is often made in the bark and branches, and hence the necessity of rest, and the notorious fact that many trees will bear a crop only in alternate years.

Liebig considers that the object of the winter rest in wheat is to give time for storing up nutriment in the roots for the formation of the stalk and ultimately of the seeds in the fructifying stage.

"A very mild autumn or winter," he says, "operates unfavourably on the future crop, as the higher temperature encourages the development of the principal stalk before the proper time, and consumes the food which should have served to form buds and new roots, or to increase the store of organisable matter in the roots. Thus stunted in its development, the root supplies less food to the plant in spring, as it takes up and gives out less in proportion to its smaller absorbent surface and more limited supply stored up in it, and it retains the same feeble character in the succeeding periods of vegetation. The agriculturist endeavours to meet the difficulty by grazing down or cutting these feeble plants; the formation of buds and roots hereupon begins anew, and if the external conditions are favourable, and the plant has time to fill the root with a fresh store of organisable matter, the normal conditions of growth are, in the agricultural sense, restored."

As regards cereals, the process of vegetation goes on continuously in most varieties; but in winter-wheats there is often a period of rest. The circumstance here, however, is rather accidental than essential, and dependent on their requiring a longer time to come to maturity. Our author's reasoning on this matter seems to partake too much of theory. Excellent crops are often produced where there has been no winter rest, provided the growth is not so rank as to prevent proper ventilation; and one object at least of feeding off is to obviate an excessive development of tillers, which are sure, in the end, to be comparatively unproductive, either from the layering of the crop, or the want of space for healthy growth, which cannot take place without due admission of light and air.

There is a circumstance about most leguminous plants which has not yet been sufficiently studied. From the earliest period of growth, little tuberiform bodies are formed upon the roots, which have been described as Fungi. They sometimes acquire a considerable size, as in the common acacia. Like the secondary roots themselves, of which they appear to be modifications, they are derived from within and burst through the outer coat, soon becoming much inflated, and often corrugated. Their walls are thick and fleshy. The lower part of the axis consists of elongated, close-packed cells, while the swollen portion, at least in the kidney-bean, is filled, especially above, with tissue

abounding in starch-grains. In the common bean, three weeks after sowing, the cells have a delicate salmon-tint; but to what this is owing I am not able to say, as I have never had time to follow out the subject. These bodies are doubtless occasionally important organs in time of drought; though it is very possible, as many of them become effete at an early period, they serve some especial object besides. The late M. Desmazières, many years since, pointed out to me some curiously-shaped extremely minute bodies to which they give rise; but I am not aware that they have been studied in different stages of development, and at different periods in the growth of the plant. Something very analogous occurs in many conifers; but in this case, as before, further examination is requisite.

An interesting subject still remains for consideration—namely, the activity of absorption in the spongelets at different periods of growth. The comparative chemical result of the produce at different periods is not a certain indication of this, because this may depend upon matter already deposited in the roots, and suddenly brought to bear as occasion requires. Unless some method could be devised by which the proportion of nutritive matter in a given quantity of soil at different periods could be estimated, it is difficult to see how the matter admits of determination. Even comparative estimates as regards the whole plant are but few in number, and at present unsatisfactory. It is difficult, moreover, to estimate the quantity of active absorbing surface at different periods, as old spongelets are constantly decaying.

It appears, however, from Anderson's *Observations on Turnips*, published in the 'Journal of Agriculture and Transactions of the Highland Society,' that, "in the first half of the time of vegetation, the organic labour in the turnip-plant is principally directed to the production and development of the external organs; during a second period of 35 days, 9 parts of the food absorbed going to the leaves and 2 parts to the roots; while in a third period of 20 days, 9 parts remained in the leaves and 16 parts in the roots. During a fourth stage, the weight of leaves kept constantly decreasing, while that of the roots increased, the proportion being much larger than in the third stage.

On chemical examination it appeared that the quantity of phosphoric acid was daily increasing; the potash increased rapidly during the second and third stages, and then decreased; the absorption of sulphuric acid was nearly uniform, while that of salt gradually increased and then slightly diminished. As regards lime, magnesia, and iron, the absorption showed every day a trifling increase, corresponding to the increased absorbing surface, but otherwise uniform; and the same may be said, with slight modifications, such as future analysis might alter, of the

other substances, except potash. As regards nitrogen, Anderson is himself doubtful whether it has been correctly estimated.

Ahrend has examined the oat-plant in a similar way, but extended his investigations to the ripening of the seed, and exclusive of the roots. It appears that the increase of potash was rapid during the time of flowering up to the formation of the seed, during the ripening of which there was no further increase; that the increase of phosphoric acid and nitrogen was still more rapid during the same period, but that there was an accession of phosphoric acid during ripening, and a still greater accession of nitrogen. The activity of the leaves, as in the former case, during the earlier stages, appears to have been directed towards the production of organisable matter to be stored up for the shooting stage, and ultimately, as in the turnip, to be employed in the formation of seed. The absorptive power of the roots in all probability still remains the same, except so far as the increase of temperature might stimulate it. The matter, however, at present has been very insufficiently studied, and requires further and more varied investigation.

The following are the conclusions which we may gather from the preceding remarks:—

1. That the first effort of vegetation in the sprouting embryo is to develop properly the plumule, on which every succeeding stage depends.

That in order to this there must be a proper quantity of nutriment stored up in the seed, as well as a supply at once available from the soil, and that to accomplish this profitably a proper selection of seed is highly requisite.

2. That the second object is to cause such a development of the roots as may present a sufficiently large absorbing surface to produce a rapid and healthy growth of the vegetative parts of the plants; an end which must be formed by a proper texture of the soil, and the presence in it of such chemical constituents in their due proportions as are appropriate to the especial crop under cultivation.

That for this end roots have a certain power of selection, rejecting what is injurious, and absorbing in their proper proportions those elements which the particular nature of the plant requires.

That meanwhile they have no power of excretion, and therefore pauperise the soil merely by consumption.

3. Finally, that in many cases certain portions of the roots are differentiated as storehouses of nutriment for the fructifying stage, while in others the whole mass of roots serves to this purpose.

XXIV.—On M. J. Reiset's Agricultural Experiments.*

By P. H. FRERE.

AN interesting contribution to scientific agriculture has lately been made by M. Reiset, who appears to combine in a high degree the character of a learned chemist with that of a sensible farmer. This combination is as valuable as it is rare: for the mere farmer is often uncommunicative or unable to impart to others his own conclusions; whilst if any one speak as the mouth-piece of pure science, his dicta, when confronted with practice and tested by experience, are pretty sure to require qualification.

The scientific attainments of M. Reiset have been displayed in various communications to the 'Annales de Chimie et de Physique,' &c. A gold medal, presented to him by the Agricultural Society of Rouen, is evidence of his reputation as a farmer. Since 1850 he has farmed some 250 acres of his own land, near Dieppe, where he planted his laboratory, with the purpose of bringing his scientific researches to the test of the balance-sheet. Having the advantage of good markets he was well situated for trying *intensive* culture, "or that system of management which gives the land no rest, but aims at securing a maximum crop by a liberal outlay." Accounts have been kept and stock taken with the utmost care to make them unimpeachable; wear and tear and costs of cultivation have been duly calculated, and from the survey of these details several weak points in the enterprise struck the mind of the owner, particularly the heavy expense which arises from wintering stock without a supply of roots.

After some fourteen years of unremitting attention to these points M. Reiset writes:—"Unfortunately there is nothing more difficult than to explain (*mettre en relief*) processes adopted in the cultivation of the soil, to exhibit the reasons for these processes, and to state in detail the systematic management of the farm, as can be easily done for any commercial undertaking." Baron Liebig, on the other hand, in the preface to his 'Natural Laws of Husbandry,' says, "I have never yet met with an agriculturist who kept a ledger, as is done as a matter of course in other industrial pursuits, in which the debtor and creditor account of every acre of land is entered."†

* 'Recherches Pratiques et Expérimentales sur L'Agronomie.' Par J. Reiset, Correspondent de L'Institut de France. (1863. J. B. Baillière.)

† There is certainly a remarkable contrast between these passages. M. Reiset, having had practical experience in farming, would probably award some praise to the farmer who could give a clear account of the expenditure and receipts of any one field on his farm; whereas Baron Liebig, giving as he does to tradesmen an undue amount of credit for method and accuracy, founds a reproach upon what is an imperfect analogy.

M. Reiset has prefaced his scientific researches by an abstract of his proceedings in stocking and managing his farm, which is full of good sense. Having no pasture, he wisely turned his attention to sheep, rather than oxen, selecting an improved native race (Charmois) and crossing it, first with Leicester blood, and then, to better effect, with Southdown rams. But for early fattening, his experiments show that these foreign crosses are still much inferior to our English sheep.

His first step to the improvement of his land brings out in striking relief the strong and weak side of the position of a scientific and liberal reformer. He found that the sewage of Dieppe ran to waste on the sea-shore; analysed it; found that it contained more than 1 per cent. of nitrogen; contracted to buy it at 1s. 3d. per ton; carted it some six miles to his land, and, by applying 20 tons per acre, grew 40 tons of mangold and 50 bushels of rape-seed per acre. The Agricultural Society of Rouen verified these results, and recognised their importance by the award of a gold medal. Thus far we have a bright picture. But when public attention was aroused, farmers close at hand became competitors; the price rose from 1s. 3d. to 10s. and 12s. per ton, and M. Reiset was driven out of the market. Some will think, if not say, when he had got hold of a good thing, why did not he keep it to himself? But the liberal man stands by liberal things, because he has, not a nostrum, but a living power, and he is not at his wits' end when one device fails him. When this extraneous source of fertility was cut off, a distillery, built and supplied with mangold on the farm, afforded both a high price for the produce and a home store of food for stock, and so of manure, from which no fertiliser of material value had been abstracted by the spirit, which was manufactured and exported.

The great practical question of our day appears to be how we are to produce economically a greater supply of meat. The cultivation of mangold with a view to distillation, appears thus far to be the French solution of the question, and as such deserves some special attention. As a consequence of the new demand for roots, the four-course was substituted for the scourging three-course of the district, viz., wheat, oats, and *industrial* crops, principally rape (grown for seed), under which system the old-fashioned farmers around had just kept the wolf from the door.

The supply of mangold pulp led to stall-feeding cow-stock; autumn purchases, or crowded houses, as usual introduced pleuropneumonia. M. Reiset grappled resolutely with the malady. Inoculation was tried on a large scale, under the charge of M. Delafond. "I cannot affirm," says M. Reiset, "that this is a certain means of prevention, but assuredly it is not at all dangerous when carefully executed, and may be recommended to all

those who are exposed to this scourge." In the following year, as sheep—chiefly aged ewes—are abundant and cheap in the district, they were substituted for cow-stock; and of late 600 sheep have been fattened in the winter, producing 600 cwts. live weight of prime meat.

Experience in dealing in stock has led M. Reiset to make the following remarks:—"Marketing plays a prominent part in the lives of our agriculturists, and has for them a special attraction. If we inquire into the real means by which some among them have made fortunes, we shall often find that their prosperity is due to the skill which they display in repeated purchases and sales, rather than to their intelligence in the management of their land."

These hints from practical life will prepare the reader to follow with livelier interest and more of faith the scientific researches which form the bulk of the volume.

The subjects treated of are:—

1. Experiments on the composition of milk, taken at the beginning, middle, and end of the milking.
2. Experiments on grain, in respect of its weight per measure and its specific gravity at different degrees of dryness and maturity; the relation between the weight per measure and the nitrogen, or gluten, contained in the flour, and consequently its value as bread; and the question of sale by weight or by measure.
3. On the fermentation of dung, and on putrefaction.
4. On sheep-feeding with mangold pulp.
5. On the comparative feeding value of mangold given raw, steamed, or as distillery refuse.
6. Analyses of several varieties of rape during the second year of growth.
7. Movable sheep-sheds.
8. Farm distilleries, their management, yield of sugar from mangold of different sizes and varieties—weight of crops.
9. Experiments on the respiration of animals.

Of these investigations some few will interest the practical man; others concern the foundations on which science is slowly but surely built. No better evidence can be given of the utility of some of the points investigated than the fact that these also form the bases of Professor Coleman's estimates, as stated in his paper reported in page 623 of this Journal. The eminently practical manager of the model farm and the man of science who farms for himself, come to view things in the same light, though their estimates exhibit slight variations.

On the Weight and Feeding Quality of Wheat.

M. Reiset made many experiments to determine the weight per bushel, and specific gravity, of the grain of various kinds of

wheat at different stages of growth and in different states of dryness, with special reference to their feeding value, and to the question whether sales should be effected by weight or by measure.

The specific gravity of a *grain* of wheat is determined by comparing it with the same bulk of water; if this expression can be applied at all to the *bushel* it then refers to an imaginary quantity—the weight which would result if the grains had no spaces between them. The amount of these spaces evidently depends upon the form of the grains; so that a long, thin, dry wheat, of greater specific gravity, may weigh less *per bushel* than a plump, round sample, of less density in itself. Careful measurement of 20 kinds of wheat from different countries showed that the specific gravity or density of wheat varies from 1290 to 1407; that is to say, a measure which, when filled with water, weighs 1000 grammes, would weigh from 1290 to 1407 grammes if it could be so filled with wheat that no intervals were left between the grains; whilst, if the measure be actually filled as corn is usually measured for sale, the weight will vary from 739 to 816 grammes (equivalent to $58\frac{1}{2}$ and $65\frac{1}{4}$ lbs. per bushel).* A practical rule for measuring corn is given as follows:—Pour the grain from a shovel held 4 inches above the measure, fairly into its centre, without shaking it, and *strike* the surface once. For these experiments, however, a small apparatus made by M. Busche was employed, in which the feeding-pipe can be very exactly regulated.†

Of these varieties, that which had the greatest specific gravity or density (1407) was a very hard Polish wheat, which only weighed $59\frac{1}{2}$ lbs. per bushel, whilst a white Russian variety, grown in France, weighing 65 lbs. per bushel, had the density 1378, and the Albert (grown from English seed, and weighing $63\frac{1}{2}$ lbs. per bushel) density 1358. The actual weight of the bushel of wheat does not therefore tally with its specific gravity.

These trials were followed by researches into the amount of water found in wheat under different circumstances, and the effects of its absorption and evaporation on the weight and bulk of the grain. The most remarkable points of practical interest brought to light by these inquiries are: 1st, that each variety of wheat naturally contains a certain quantity of moisture, and if either wetted or dried, promptly takes occasion to return to its

* The results of such experiments can be far more neatly expressed in modern French measures adapted to the decimal scale than by our English standards, which our scientific writers appear to be abandoning even in English treatises.

† It had been previously ascertained, that by shaking the measure it may be made to hold as much as from one-thirteenth to one-tenth more than its usual contents.

normal condition as to *dryness*, but when dried after having been swollen by water, it does not recover its former *bulk*. The percentage of water in the 20 specimens examined varied from 12.20 to 16.51.

The author had supposed that by drying the grain he might increase the weight per bushel almost at pleasure; the result showed the contrary. For when Albert wheat, having 16.11 per cent. of moisture, the density 1398, and weight 815.3 (= 65 lbs. per bushel), was so dried that the water was reduced to 7.24 per cent., the density was increased to 1420, but the weight per litre diminished to 797.8 (= 63.6 lbs. per bushel).

And again, white Russian wheat, having moisture 15 per cent., density 1378, weight 816, when reduced to 7.7 per cent. of moisture, had density 1400, and weight 803. Trials made at different stages of the process showed that the density constantly increases as the proportion of water diminishes. The grain undergoes a manifest contraction, but this is not in proportion to the amount of water lost; therefore the actual weight of the measure decreases perceptibly with the loss of the water.

The effects of moistening grain were more remarkable. Some Spalding wheat, when spread in a thin layer and exposed to air saturated with moisture at the ordinary temperature, gave the following results:—

Percentage of Water.	Density.	Apparent Weight per litre.	Weight per Bushel.
Wheat in its natural state.			
14.69	1382	782.3 grs.	62.43 lbs.
Wheat after absorbing moisture.			
15.82	..	773.1	..
16.96	1375	771.1	..
19.29	1360	739.0	58.96
31.17	..	671.9	53.65

After being thus saturated, the wheat, when exposed to the open air in a thin bed, lost in two days exactly the extra 16.48 per cent. of water which it had taken up, and so returned to its normal state of moisture; but its specific gravity remained fixed at 1361 instead of 1382, and its weight per bushel was 59.1 lbs. instead of 62.4 lbs. Grain, therefore, when accidentally swollen by moisture, does not upon drying return to its original bulk, but remains distended, and loses both in density and in weight per bushel.

"It is probable that corn much wetted in the course of the harvest undergoes some such a change as this experiment ex-

hibited; the grain is swollen, and, in spite of every attention being paid to it, will not resume its former natural bulk."

A further experiment, made on a Neapolitan white wheat (Richelle), confirmed these results. In this case, 420 grammes were moistened until they were at the sprouting-point; they then weighed 540 grammes, and had therefore absorbed 28 per cent. of water.

After being dried for 4 days in the open air, the wheat returned to its original weight, and had therefore given up all the water it had absorbed. At the first the density of this wheat was 1381, its weight per litre 801.1 grammes (or 64 lbs. (nearly) per bushel); at the last the density was 1327, and the weight per litre 706.4 (=56 lbs. per bushel).

In the wet season of 1850 the crop actually grown on the farm had the specific gravity 1350, and weighed 748 grammes (= 57½ lbs. per bushel).

This shows clearly that wheat measures well after it has been damped, and that it will not lose much of its acquired bulk if kept till it is fairly dry again.

M. Reiset next approaches the question of nutritive value: he assumes that this will vary with the amount of gluten and albumen, and proceeds (in accordance with M. Boussingault's teaching) to *ascertain* by two methods the nitrogen in the grain, from which he may then *calculate* the gluten and albumen contained in it.

He finds that the nitrogen in the grain varies from 1.71 to 2.87 per cent., equivalent to 10.63 and 17.93 per cent. of gluten respectively, allowing 16 of gluten to 1 of nitrogen; that there is no apparent connection between the amount of gluten found in any variety and its weight per bushel, but an evident relation between the gluten and the density. As a rule, the dry hard glazed wheats, such as are generally sought for in the manufacture of macaroni, &c., have the greater density and the most gluten. The amount of ash (which is from 1.77 to 2.25 per cent.) generally varies with the nitrogen.

Estimated by this standard, wheats have a very different feeding value, which is but ill appreciated in the markets.

To bring out this distinction, a comparison is made between Barker's stiff-straw wheat, containing 16.51 per cent. of water with 9.54 per cent. of gluten, and a wheat named Hérisson (the Hedgehog), grown near Arpajon, containing 13.48 per cent. of water and 15.51 of gluten. Merchants would prefer the English wheat, because the grain is plump and tender, and, if they bought the other at all, would insist on a lower rate, because its kernels are small, glazed, and ill-shapen; yet as much nitrogen is contained in 100 lbs. of the latter as in 162½ of the English wheat.

Suppose, says M. Reiset, that the labourer can buy these two

wheats at the same price, and that he eats 20 lbs. of bread per week, or 12½ lbs. of dry food, (since bread contains 30 per cent. of water) then his allowance in bread made from English corn would contain 108 grammes (3·8 ozs.) of nitrogen, and, in French, 168 grammes (5·9 ozs.), and this difference of 60 grammes represents the nitrogen in 60 ounces of meat. The inference is, that biscuits made from dry, hard wheat would give a sort of *meaty bread*, which would have a special value in preparing supplies for the military service; and that tail wheat affords a more nutritious diet, though not so white a loaf as head corn, for farm labourers.

Now all these conclusions hinge on the law, here assumed absolutely, that the nutritive value of food varies with the amount of nitrogen contained in it; yet we have been taught by Dr. Voelcker that a superabundance of nitrogen is often but a sign of immaturity. Indeed, M. Reiset recognises the truth of this view, when, enlarging on the fact that in 1852 the tail corn of the Victoria wheat contained 15 per cent. of gluten, and the head corn only 13, he writes:—"These facts go to prove that at a certain phase in their growth the grains of wheat contain an equal proportion of nitrogenous matter; but it would seem that in the last period of their development the starchy matter is gradually associated with the nitrogenous element: the greater proportion of nitrogen in the tail corn may be thus accounted for." But it will be strange if that which is a sign of immaturity be at the same time indicative of superior nutritive power. Within certain limits, indeed, wheat cut before it is dead ripe is preferred as giving a stronger flour, but within these limits M. Reiset did not find that the nitrogen varied to any extent. Some experiments which he made in 1852, with some Spalding wheat and a foreign variety, gave these results:—

Date of Cutting.	Percentage of Water.	Percentage of Gluten.
July 24. Grains soft	16·7	13·81
July 29. Grains beginning to form flour	16·4	14·43
Aug. 11. Grain quite hard	16·2	13·93

Second experiment. Another wheat grown on sandy soil:—

July 15. Grains soft	17·41	13·34
July 20. Grains firm enough	16·94	12·74
When dead-ripe	16·54	14·50

Within these limits, therefore, for the same sorts similarly circumstanced, the small variation of the gluten appears to follow no distinct rule.

That such considerations as these are to our purpose, is indicated by the fact that of the wheats analysed, that which stood next to the Hérissou in respect of gluten, was a spring wheat, the "Blé Victoria de Mars;" whilst the name of Hérissou, or "Hedge-

hog," would itself seem to point to a short-eared, bearded variety, such as is not much in favour with millers. But further; Mr. Lawes and other authorities, whilst they recognise the high importance of a certain portion of the food being rich in nitrogen, do not consider that any proportional benefit will be derived from increasing this element beyond very moderate limits.

It would seem that both in the soil, in the plant, and in the animal, nitrogen may be considered as a stimulant; that is, as an agent which calls actively into play the services of other bodies, besides, or instead of, taking a part in the work itself. In the soil it renders mineral substances assimilable, or, as Liebig terms it, brings them from a state of chemical, into one of physical combination. In building up the plant, according to the same authority, it would seem that nitrogen acts in part as a moulding power, which, when one cell is completed, transfers its energy to the formation of a second, leaving but little of its own substance built in among the particles which it has brought to coalesce together. So, further, a writer in the Bavarian 'Centralblatt,' of 1861 (p. 224), writes that "the nitrogen in rape-cake renders assimilable the masses of fodder, which otherwise would be driven through the animal to no effect:"—a doctrine which the striking effects produced by supplementing sewage-grass with a little oil-cake in the Rugby experiments, tend to confirm.* If, then, on the one hand, it may be very bad policy to leave any animal at any age on any keep without some small quantity of food rich in nitrogen,—on the other hand, the rule, that nutrition varies as the nitrogen supplied, may have very definite limits, and no good may be gained by passing beyond these, since it is probable that in the last stage of fattening stock the *fatty* matter especially is associated little by little with the nitrogenous elements, in the same manner as M. Reiset tells us the *starch* is accumulated in the final development of the grain.

Opinions such as these appear to be gaining ground among English agriculturists, and the ready acceptance which these limitations meet with tends to show that they are not so blindly prejudiced and obstinate as they have been represented. In stock-feeding they gladly modify their views as to the requisite supply of nitrogen; and for manuring their lands, if they could only meet with satisfactory evidence on practical authority, they would act in the same manner, and would be only too glad to limit a costly investment which much interferes with profit.

But M. Reiset not only employs the nitrogen standard as a means of contrasting two kinds of wheat, but also for instituting a comparison between meat and bread as food for man. That we

* See Report, 1862.

may not overstrain a passage, perhaps used chiefly in illustration, it will be well to quote it as it stands:—"To give to these results (the distinctions between the English and Hérisson wheat) their full significance, we will represent these proportions of nitrogen in the form of meat; and if, in accordance with my analyses, we allow that beef contains 3.50 per cent. of nitrogen, and 68.14 of water, we may say that 108 grammes (3.8 ozs.) of nitrogen represent 3085 grammes (6.78 lbs.) of meat; and 168 grammes (=5.9 ozs.) of nitrogen represent 4800 grammes (=10.56 lbs.)—a difference of 1715 grammes (60 ozs.) of meat per week, or 245 grammes per day, in favour of the wheat which is most rich in gluten."

According to this standard, then, not only the prime wheat in the market is not really superior to that which is considered inferior, but a meat diet may have little or no advantage over one that is simply farinaceous, since an allowance of 20 lbs. of bread per week, made from a wheat of little repute, may be equivalent to 10½ lbs. of meat, or to, say, 1 lb. of meat and 1 lb. of bread per day. Such a result is, perhaps, as startling as the subject is interesting; and here, again, careful research may show that the more nitrogenous diet is only more beneficial, because it is more stimulating; and that such stimulus is only wanted when, from constitution or habit of life, the natural powers of assimilation are weak; or when over-taxed nervous energies, rather than the ordinary play of the limbs and muscles, are to be provided for. The function of meat, then, the most nitrogenous element in human diet, seems to present some further analogies to the action of nitrogenous food, such as beans, given to animals; and our view of nitrogen as a stimulant may be still further extended. It will, however, by no means follow from this general recognition of the virtue of nitrogen, that in all cases and to any extent, food is valuable in proportion to the nitrogen which it contains.

To infer the nutritive power of food from this test, is nearly the same thing as to reckon the available productive power of a field by the same standard applied by the aid of an analysis of the soil. How deceptive this latter course would be, both the careful experiments of Boussingault and the doctrine of Liebig sufficiently testify.

As in the field fertility practically depends, not on the presence of nitrogen, but on the state of combination in which it exists,—so in food the nutritive power may well depend on the manner in which the structure of the plant has proceeded, and the approach it has made towards perfection.

No one knows better than the chemist, that in nature the products of a few simple elements are as varied as the chimes

rung on a peal of bells; that some slight transposition, which we cannot detect, alone differences the most useful from the most noxious substances:—

“tantum series juncturaque pollet,
Tantum de medio sumptis accedit honoris.”

If in the natural processes something has gone amiss, whereby, according to prevailing theories, the abortion would seem to be rendered superior to the perfect creature, surely in the present state of our knowledge it would be more wise to infer incompleteness in our guesses at science, than to assume on such evidence that practice, supported probably by physiology, is blind and wilful.

As for the question of the sale of corn, M. Reiset states that in France when corn is nominally sold by measure, they always require that it be made up to a certain weight, and that the hectolitre with its makeweight (*comble*) then represents 110 or even 115 litres of corn; or else, if only 100 litres are delivered, the price is modified according to their shortcoming in weight.

He concludes that there is no advantage, direct or indirect, in retaining any reference to measure in the sale of corn, since the weight per bushel is no indication of nutritive value: whilst his careful experiments enlighten the uninitiated as to the difficulty of defining what a measure of corn is, when so much depends on little expedients employed in the measuring.

Experiments on the Feeding of Stock.

These experiments are reported in great detail: the amount of food supplied, and the percentages of nitrogen which it contained; the amount of the solid and liquid excrements and their nitrogen; the gain in live weight; the weight of each carcase, with its fleece and tallow, and the percentages of nitrogen contained in these; the value of the food and of the animals, being all stated with the utmost precision.

Such details are indispensable for the proper appreciation of the value of the results. Thus alone can it be shown that each animal was a fair specimen and its health and comfort continuously maintained, and therefore that the results are normal. It is not, perhaps, advisable to dwell upon those features in sheepfeeding which have held a prominent place in the numerous experiments already recorded in these volumes; they shall, therefore, only be briefly noticed in subordination to other points which have more of novelty, and as they serve to contrast the English and French breeds of sheep. But it must not be forgotten that there is no royal road to knowledge; not a word is redundant in the eighty pages of this record, written with all the perspicuity of the best French style; so that to condense and popu-

larize this report is a task of no little difficulty, and a thorough insight can only be obtained by reference to the original work.

The question of the greatest novelty and importance worked out in these pages is that of the proportion which the amount of nitrogen found in the excrement bears to that which has been supplied in the food. The practical questions whether stock should be fed on cake or guano bought; what allowance should be made to an outgoing tenant for nitrogenous feeding-stuffs consumed; the sum to be put to the credit of the cattle account for manure made—all hinge upon this question; and we can hardly be said to have any real *knowledge* on the subject. But these considerations cannot be severed from those of diet, increase, health, and, in a lesser degree, breed and age. Again, the rationale of fattening stock has of late undergone a revolution. When corn was taxed and and guano unknown, oilcake almost alone provided the supply of nitrogen for the growth of wheat which high prices rendered profitable. Times have changed, but we have hardly yet got out of the ruts of custom, although economical feeding is now on the increase, and it finds a most decided advocate in M. Reiset.

Again, it is interesting to contrast our sheep and their management with the flocks of our neighbours; and we have seen that M. Reiset discreetly took to sheep-farming rather than grazing cattle; so that, with the exception of one lot of eight cows, sheep are the subjects of his trials.

His flock is the Improved Charmois, and it has been crossed first with Leicester rams, then with Southdown. A second cross of Leicester and a first cross of Southdown were subjects of these experiments. The advantages already gained are that the animals are fattened at 21 and 24 months, instead of at 4 years of age. Picked specimens, are valued when fat at 32 francs (1*l.* 5*s.* 7*d.*). Such sheep, weighed alive when fasting, between 8 and 9 A.M., gave an average of 91½ lbs. When killed in this store condition they gave the following percentages:—

The four quarters	..	..	..	..	..	48·57
Skin and fleece	..	..	..	..	..	11·19
Tallow	..	..	..	..	..	6·52

When, at the end of one experiment, the sheep were killed as fat, two carcasses weighed 59·2 lbs. and 56·3 lbs. respectively; being only 45·5 and 43·4 per cent. respectively of the live-weight. Even 12 prize fat sheep (first cross of Leicester), 27 months old, gave only these averages:—

						lbs.
Live-weight	..	..	..	..	..	155·4
The four quarters	..	..	..	..	..	79·2
Tallow	..	..	..	..	..	19·6

or, for 100 of live-weight, 51 of carcase, 13·08 of tallow.

On the other hand, when placed in the stalls, they appear to eat only from 7 to 11 lbs. of mangold per day, with about $\frac{1}{2}$ lb. of bran and $\frac{1}{2}$ lb. of straw-chaff. In general, the carcasses are worth 40 francs (or 32*s.*) apiece, meat being valued at 7*d.* per lb.; and their fleece (5 $\frac{1}{2}$ lbs.) is put at 5*s.*

The great bulk of the sheep fattened were aged ewes, bought at 16*s.* apiece.

Being accustomed to sell sheep of a hardy rather than precocious race (Blackfaced Downs), the wethers, fat at 16 months, weighing over 80 lbs., and worth, with the fleece, 3*l.*, and the ewes for stock 3 months later, so as to realize at least the same value, I cannot think these French results very satisfactory; though I must admit that my sheep would eat twice as much mangold, in addition to a moderate allowance of corn and cake.

The next point to consider is the food, of which on this farm the main staple is mangold-pulp, the refuse of the distillery. The object of one of the most careful experiments is to compare this pulp with mangolds, raw, and steamed, only such an addition of straw, chaff, and bran being made as was considered essential to health. Bran and oats, either crushed or whole, with straw (long, or cut into chaff), are the only adjuncts in general use; and on a special trial, the addition of oats to pulp and straw given in the rack was not found remunerative. The diet, we must admit, must be suited to the stock that eats it.

The Waste of the Nitrogen in Food.

The first experiment recorded was made for the special purpose of testing the quantity of nitrogen recovered in the manure and in the carcase, that so the waste by the breath, &c., might be arrived at.

Five sheep were selected and weighed, of which two were slaughtered at once to determine the proportions of meat, wool, offal, &c., at the starting-point. The three survivors were put into a stall so floored that all the excreta could be preserved together. The food was steamed mangolds, bran, and oats. At first the animals lost their appetite, so that on the fifth day the three only ate 3 $\frac{3}{4}$ lbs. of pulp and 1 $\frac{1}{2}$ lb. of oats, and consequently lost weight rapidly. Something was clearly amiss. Accident pointed out a remedy; for the sheep, when taken, after 41 days, to the weigh-bridge, rushed forward greedily to devour some long straw which lay in the way. The hint was taken, but the straw supplied was cut into chaff and placed in the manger, that the investigation of the manure might not be impeded. This first essay under difficulties may be considered useful only as bringing out the worth of straw as a *stay* to the stomach ("lest," or ballast,

as M. Boussingault named it), and the excess of nitrogen in the secretions (probably in the urine) which any derangement in health occasions. The whole trial is divided into four periods: the first, of 41 days, represents failure; the second (32 days) the rally; the third (72 days) continuous progress; the fourth (18 days in May) gave a hint to conclude. After the first period the third sheep was drafted, being sick and maltreated by the others.

In the third period, the course of events was uniform and steady; it therefore offers the surest basis for general conclusions. The two sheep ate regularly per day of steamed mangolds at first 9 lbs., but soon 11 lbs.; bran 2·2 lbs.; oats 2·2 lbs.; of straw-chaff a ration, which decreased from 1½ lb. to 1 lb. as the weather grew warmer. The average of food taken per head per day was—

						lbs.
Mangold steamed	..	..	..	..	..	5·36
Oats	..	..	..	..	..	1·10
Bran	..	..	..	..	..	1·08
Straw	..	..	..	..	..	·58
In all						8·12

The increase in live-weight, ascertained every week, was steady; they never went back. In some weeks there was an *apparent* gain of 4 lbs. per head; in a few others no apparent gain; but the varying state of the bowels might account for such fluctuations consistently with steady improvement. The entire gain in live-weight amounted—

						lbs.
In one sheep, to	..	..	..	..	..	24·2
In the other	..	..	..	..	..	17·6
						41·8
Average	..	..	..	..	..	20·9

or more than 2 lbs. per week.

The amount of the mixed manures collected daily averaged 5·23 lbs. per head, and contained ·0332 of a pound of nitrogen. It was valued at 1*d.* 87 per day, the nitrogen being set at nearly 6*d.* per lb., and no account taken of other constituents, which probably bore nearly a constant ratio to the nitrogen.

We now come to the points to be specially determined in this trial, which it will be well to state in some detail.

The amount of nitrogen in the food was thus determined.

The nitrogen in the mangold was set at 0·160 per cent. This was the mean of all the analyses, of which two were taken in December, seven in January, and five in February.

The nitrogen in oats was (mean of 4 analyses)	..	..	1.660
„ „ bran (mean of 6 analyses)	..	..	2.269
„ „ straw (mean of all the analyses)	..	..	1.220

The total of the food consumed was—

	lbs.	grammes.		lbs.	grammes.
Mangold	.. 772.8	351.290	containing nitrogen	1.2364	562.064
Oats	.. 159.5	72.500	„	2.6479	1203.500
Bran	.. 145.2	70.570	„	3.5222	1601.233
Straw	.. 84.6	38.460	„	1.0218	469.212
				<hr/> 8.4283	<hr/> 3836.009

“ From the 22nd of February to the 4th of May the two sheep produced of mixed excrement 342,360 grammes (753.2 lbs.), or on an average 4755 grammes per day (10.46 lbs.), or 2377 grammes per head (5.23 lbs.) (The average weight of food was 8.12 lbs. per head, of which 2½ lbs. was dry food.)

“ If in calculating the nitrogen in the excrement we take the mean of .635 per cent., deduced from analyses made from February 15 to February 21, and from May 5 to May 9, we find that these 342,360 grammes of excrement ought to contain 2174 grammes (4.78 lbs.) of nitrogen.

“ Each sheep, therefore, voided 15.097 grammes (.0332 lb.) in 24 hours as excrement.

“ The money value of the excrement produced in 24 hours (2377 grammes) is 0.039 of a franc (this comes to 2d.18 per week), taking as a basis for our valuation the price of guano or cake.”

	grammes.	lbs.
Since the nitrogen in the food was	.. 3836.009	8.4282
And that in the manure	.. 2174.000	4.7828
	<hr/> 1662.009	<hr/> 3.6454
There remains to be accounted for	.. 1662.009	3.6454

The cost of the keep was thus estimated :—

	£.	s.	d.
7 cwt. of mangold, at 10s. per ton, nearly	..	0	3 6
158½ lbs. of oats, at 5l. 12s. per ton	..	0	8 0
154 lbs. of bran, at 6l. 8s. per ton	..	0	9 0
83½ lbs. of straw, at 2l. per ton	..	0	1 6
		<hr/> 1	<hr/> 2 0
The value of the manure at 4 centimes per head per day comes to	..	0	4 8
Or about 21 per cent. of the cost of the food,			
leaving, as a charge against the sheep	..	0	17 4

Since the increase in live-weight was 41.8 lbs., the cost of feeding is 4½d. per lb. of live-weight gained.

It thus appeared that of the nitrogen contained in the food only
2 g 2

56 per cent. was recovered in the manure, and that the value of the manure was one-fifth of that of the food.

We will now pass on to the conclusion of the experiment. May 21, when the two sheep were killed, with these results:—

	Sheep No. 60.		Sheep No. 67.	
	Weight.	Percentage of Live-Weight.	Weight.	Percentage of Live-Weight.
	lbs.		lbs.	
The four quarters	56·3	43·4	59	45·5
Tallow	12·5	9·6	19	14·7
Skin and fleece	17·6	13·5	14·5	11·2

At the beginning of the experiment in December, No. 60 weighed 88 lbs., and, at the last, 130 lbs., an increase of nearly 42 lbs.

No. 67 weighed at first 99 lbs., and at last 130 lbs., showing an increase of 31 lbs. live-weight.

If the constitution of these two sheep at the first be calculated according to the proportions of the two sheep then slaughtered, we shall come to the following ultimate conclusions as to their increase.

	Sheep No. 60.		Sheep No. 67.	
	Original Proportions.	Increase.	Original Proportions.	Increase.
	lbs.	lbs.	lbs.	
The four quarters	41·7	13·57	48·08	10·96
Fleece and skin	9·8	7·75	11·07	3·44
Tallow	5·7	6·80	6·45	12·48
		28·12		26·88

It results from these figures that No. 60 exhibits an increase of 41·8 lbs. live-weight, but only of 28 lbs. of useful products, whilst No. 67 gave nearly 27 lbs. of useful products to 30·8 live increase. These anomalies are probably to be explained by the varying amount of the contents of the bowels.

It being assumed that this account of the increase is correct, it becomes easy to calculate the nitrogen assimilated by the sheep.

Some flesh selected from the cutlet gave, on analysis, a mean percentage of 3·35 of nitrogen. The wool of No. 60 gave 9·57 per cent.; that of No. 67, 7·94 per cent. (a remarkable difference); the tallow only ·32 per cent. On these data, there had been assimilated by—

	Sheep 60. grammes.	Sheep 67. grammes.
In the meat	206·762	166·964
In the wool	337·246	124·261
In the tallow	9·900	18·451
Undigested contents of the stomach ..	62·120	16·851
	616·028	326·526

or in all 942·554 grammes of nitrogen (1·97 lbs.).

The amount of nitrogen contained in the wool deserves special attention, not only on account of its absolute quantity, but of its varying proportions. In the one sheep we see that half as much again of nitrogen was assimilated in the wool as in the flesh, while in the other and inferior animal there was less in the wool than in the meat.

Thus, of 3072 grammes, the excess of nitrogen in the food over that recovered in the manure, only 942·55 grammes appear to have been assimilated, and the remainder must necessarily have passed away by respiration and transpiration.

M. Reiset remarks: "This amount of nitrogen exhaled appears at first sight to be large, and one might feel disposed to question the result, but we must remember that the experiment had lasted 168 days, and that in the first period the two sheep had experienced a remarkable loss of substance, amounting to more than 13 lbs. To recover this loss, the organism had to fix a certain amount of nitrogen, of which no account could be taken; and it will be near the mark to assume that of these 13 lbs., $6\frac{1}{2}$ were muscular tissue, containing about 105 grammes of nitrogen. This will leave us 20·25 grammes exhaled by two sheep in 168 days, or 6 grammes per head per day for sheep fed on rich nitrogenous food.

"I may remind the reader that in a paper on Respiration, published in 1849 (in the 'Annales de Chimie,' &c., 3rd Series, vol. xxvi.) by M. Regnault and myself, we show that different animals on store keep constantly exhale nitrogen. The amount of the gas then found to be exhaled was as considerable as that now arrived at by the indirect process."

The following table (see p. 452) gives the amount of food in lbs., and the nitrogen in that food stated in French grammes, for the four periods. The amount of the excrements is also given below in lbs., and its nitrogen in grammes; the difference stated.

The sum of the differences throughout, calculated for *two* sheep, amounts to 3072 grammes. The amount of the nitrogen recovered in the food was, for the four periods, 72, 57·7, 56·67, and 49 per cent. respectively.

	1st Period.		2nd Period.		3rd Period.		4th Period.	
	Food.	Nitrogen.	Food.	Nitrogen.	Food.	Nitrogen.	Food.	Nitrogen.
	lbs.	grammes.	lbs.	grammes.	lbs.	grammes.	lbs.	grammes.
Mangold	190	117	290	237·5	772	562	173	126
Oats	118	1144	59	426·5	159	1203	53	411·5
Bran .. ..	..	..	65	701·5	145	1601	35	376
Straw .. ..	..	..	60	346·3	85	470	2	11·5
Total .. ..	..	1161	..	1711·8	..	3826	..	925
Excrements .. ..	..	835	..	986·3	..	2174	..	457·6
Difference (3 sheep)	..	326	..	..	..	..	..	..
Difference for 2 sheep	..	218	..	725·5	..	1662	..	467·4

To leave no doubt on this point, M. Reiset renewed his direct experiments, and found that a stock ewe expired daily 5·4 grammes of nitrogen, and a store wether 4·3 grammes.

M. Boussingault* has put on record that a horse exhaled 23 grammes, a cow 27 grammes per day, and a pig of 9 months 4·4 grammes.

M. Barral,† pursuing Boussingault's method with three different sheep for 4 or 5 days, found that they severally exhaled 2·89 grammes, 9·38 grammes, and 6·19 grammes of nitrogen in 24 hours.

M. Reiset thus sums up his experiments:—

“Of 100 parts of nitrogen put into circulation by the food—

58·3 is recovered in the excreta.

13·7 is recovered in the meat, tallow, and skin.

28·0 is lost by respiration.

100·0”

The money value of the manure per head per day was—

	Centimes.
1st Period	1·8
2nd Period	3·4
3rd Period	3·9
4th Period	3·3

or, on the average of the three last periods, 3·6 centimes (nearly 2d.) per week.

The excrements contained from 67 to 85 per cent. of water.

M. Reiset does not pretend to be able to combine a scientific experiment with the greatest possible economy of production ;

* ‘Economie Rurale,’ 2nd edition, vol. ii. p. 332.

† ‘Statique Chénique des Animaux’ (1850), p. 311.

but since he does not share the general mistrust entertained for scientific results, he did not hesitate to apply the *principles* deduced from these trials to his general system of stall-feeding. He rejects a forcing system of feeding which is irrespective of the animal's powers of assimilation. He condemns as useless and costly the employment of corn and cake from the beginning of the fattening process, because, before this is done, the stock should be well "*ballasted*" with an abundance of *staying* cheap food. Mangold, he says, or, better still, mangold-pulp, will always bring on both cattle and sheep, so that a very little corn will complete the fattening process. He points to the fact that the animal should be *ripe* before it is sold, because the value of prime meat per pound is often double that of lean inferior meat, so that in feeding, the chief profit is often derived from the extra value attached to the superior quality of the produce.

Value of Mangold, Steamed, Raw, or as Pulp.

To test the feeding-value of mangold-pulp, and correct the exaggerated impression entertained by some persons of the unimportance of saccharine matter for feeding purposes, 3 lots, each of 5 sheep, 23 months old, the first cross of Southdown, were fed, from November 28, 1858, to May 5, 1866 days, the 1st lot on raw mangold; 2nd, on pulp; 3rd, on mangold steamed, with the addition to each sheep of nearly $\frac{1}{2}$ lb. of bran and $\frac{1}{2}$ lb. of straw-chaff. The result showed that, if mangold is valued at 10s. per ton, pulp is worth 6s. 8d. per ton; or since a ton of mangold gives about $\frac{2}{3}$ of a ton of pulp, the refuse from 1 ton of mangold is worth 5s.

In this experiment steamed mangold showed a decided advantage over that given raw, since 59 lbs. steamed were found equivalent to 70 lbs. raw.

In addition to the straw-chaff, the sheep picked a little straw out of the rack, but the amount was insignificant.

The following table gives—

- A. The total increase in live weight.
- B. The total cost of the food: mangold being valued at 10s. per ton, pulp at 6s. 8d., straw at 2l., bran at 6l.
- C. An estimate of the total value of the manure, arrived at by the confinement of one sheep of each lot for 24 hours in the cell arranged for this purpose.
- D. The amount of roots or pulp consumed for the increase of 1 kilogramme of live weight.
- E. The cost of that same increase.
- F. The nitrogen in the food for that increase.
- G. The percentage of nitrogen found in the meat.

Lot.	Mangold.	A.	B.	C.	D. E. F.			G.
		Gain.	Food.	Worth of Manure.	For Gain of 1 Kil. Live Weight.			Per-centage of Nitrogen.
					Roots Eaten.	Cost of Food.	Nitrogen in Food.	
		kil.	fr.	fr.	kil.	fr.	grammes.	
1	Raw ..	45·3	72	20	70	1·15	235	3·61
2	Pulp ..	39·9	61·3	29	101	·80	327	3·17
3	Steamed ..	58·7	75·5	23	59*	·89	187	3·0

* 59 kilogrammes of roots took up 11 of steam.

The economical results are given in the columns D, E, F, of which column E shows that mangold steamed, at 10s. per ton, is nearly equal to pulp at 6s. 8d., and much superior to raw mangold.

Column G may in some degree indicate the superior quality of the meat made in lot 1, but the variation is chiefly due to the greater fatness of lot 3; nevertheless, we are here reminded of Mr. Lawes's remarks on the degree in which meat produced by steamed food "boils away" when dressed.

At equal intervals in the course of the trials 10 analyses were made both of the mangold and the pulp; the following table gives the average results, together with the total of the nitrogen, supplied in these two forms:—

	Nitrogen in Roots Consumed.	Percentage of Water.	Percentage of Dry Substance.	Percentage of Nitrogen in Dry Substance.
	Kilogramme.			
Mangold (lot 1)	47·79	85·26	14·74	1·02
Pulp	8·36	89·06	10·94	1·89

XXV.—*Statistics of Live-Stock and Dead Meat for Consumption in the Metropolis.* By ROBERT HERBERT.

DURING the first six months of the present year, the various cattle markets in England were well supplied with English and Scotch beasts in full average condition; indeed, the supplies sent to the metropolis have scarcely been equalled since 1850. Prices, however, have continued remarkably firm under the influence of a steady consumption; the stock has, with some few exceptions, appeared tolerably free from disease, although it is understood

that numerous losses—though not above the average—have been sustained in some of our leading grazing countries.

The extreme firmness in the value of fat stock has, of course, had considerable influence upon the rates demanded for store animals, which have continued unusually high—in many instances too high to admit of profitable grazing. Taken as a whole, the Norfolk “season” for beasts has been profitable, and, judging from the weight and quality of the stock already sent from Lincolnshire, Leicestershire, and Northamptonshire, it is pretty evident that we shall be freely, perhaps largely, supplied with beasts during the remainder of the year. It may, however, be doubted whether even increased supplies will much affect existing prices. Sheep have, for the most part, come to hand in fine condition, especially from Sussex, Norfolk, and Leicestershire. Nearly all breeds have been in steady demand, at very full prices—the average value of the best Downs out of the wool having been 5s. 2d. per 8 lbs. Lambs have come forward somewhat freely, and met with a tolerably active demand at steady rates. Calves have sold freely, considering the extent of the supplies; but pigs have been less in request than in the previous season.

The following return shows the stock exhibited in the great Metropolitan Cattle Market in the first six months :—

Total Supplies of Stock Exhibited.

Year.	Beasts.	Cows.	Sheep and Lambs.	Calves.	Pigs.
1857	112,309	2682	536,790	8,420	13,240
1858	111,592	2917	588,758	8,878	13,096
1859	113,373	2977	668,702	7,272	14,869
1860	114,702	2904	662,030	9,515	14,201
1861	109,812	3005	604,650	6,560	15,952
1862	116,735	3054	631,672	8,259	17,407
1863	120,045	3005	628,072	10,449	16,435

This table shows that rather more beasts, sheep, and calves have been disposed of during the last six months than in the two previous years; but if we take into account the greatly improved condition in which they have come to hand, we shall find a very large increase in the consumptive demand for meat. In the numbers of stock given above, are included the supplies derived from abroad.

The following table shows from what districts our home supplies have been derived :—

Supply of Bullocks from various Districts.

Year.	Northern Districts.	Eastern Districts.	Other parts of England.	Scotland.	Ireland.
1857 .. ..	...	60,500	14,490	8,860	2700
1858	4,000	66,890	14,560	8,456	4820
1859	4,000	7,460	19,090	10,080	2217
1860	4,000	68,520	21,420	5,033	1477
1861	47,000	64,060	17,700	8,712	256
1862	400	68,420	29,290	9,794	2545
1863	470	66,940	16,330	9,610	1664

It appears that both Ireland and Scotland have forwarded about average numbers of stock. The Irish beasts, however, have come to hand in but middling condition. During the past fifteen years the average prices have ruled as follows:—

Average Prices of Beef and Mutton.

Per 8 lbs. to sink the Offal.

BEEF.

	1849.	1850.	1851.	1852.	1853.
	s. d.	s. d.	s. d.	s. d.	s. d.
Inferior	3 2	2 10	2 10	2 6	2 8
Middling	3 10	3 6	3 6	3 6	3 8
Prime	4 4	4 2	4 0	4 0	4 6

	1854.	1855.	1856.	1857.	1858.
	s. d.	s. d.	s. d.	s. d.	s. d.
Inferior	3 4	3 4	3 0	3 2	3 0
Middling	4 0	4 4	4 0	4 0	3 10
Prime	4 10	5 0	5 0	5 0	4 6

	1859.	1860.	1861.	1862.	1863.
	s. d.	s. d.	s. d.	s. d.	s. d.
Inferior	3 2	3 6	3 4	3 0	3 4
Middling	4 0	4 6	4 4	4 0	4 4
Prime	5 0	5 6	5 0	4 8	5 0

MUTTON.

	1849.	1850.	1851.	1852.	1853.
	s. d.	s. d.	s. d.	s. d.	s. d.
Inferior	3 6	3 0	2 8	2 10	3 0
Middling	4 0	3 6	3 2	3 8	4 0
Prime	4 4	4 2	4 0	4 6	5 2

MUTTON—continued.

	1854.	1855.	1856.	1857.	1858.
	s. d.	s. d.	s. d.	s. d.	s. d.
Inferior	3 4	3 6	3 6	3 10	3 2
Middling	4 0	4 4	4 4	5 0	4 2
Prime	5 0	5 0	5 4	6 0	5. 2

	1859.	1860.	1861.	1862.	1863.
	s. d.	s. d.	s. d.	s. d.	s. d.
Inferior	3 4	3 10	3 8	3 6	3 10
Middling	4 8	5 2	5 0	4 6	4 8
Prime	5 10	6 2	5 10	5 4	5 6

The total imports of foreign stock into London have amounted to 120,581 head, shipped from the following ports:—

Imports of Foreign Stock.

From	Beasts.	Sheep.	Lambs.	Calves.	Pigs.
Amsterdam .. ..	..	78	..	..	..
Antwerp	19	250	..	1,167	..
Boulogne .. ..	..	27	2	34	..
Bremen	589	2,118	..	..	..
Cadix .. ..	..	3	..	..	..
Calais .. ..	..	25	..	59	64
Carril	279	..	..	..	..
Corunna	542	..	..	..	..
Cuxhaven .. ..	..	470	..	..	..
Dordt	563	3,805	2,192	36	..
Dunkirk	6	..	..	..	..
Guernsey	4	..	..	..	..
Hamburg	1,021	53,098	..	29	859
Harlingen	5,864	9,812	304	683	207
Havre	32	..	..	8	..
Oporto	488	..	..	..	..
Ostend	328	43	54	352	..
Rotterdam	6,338	14,389	4,541	9,077	99
Vigo	633	..	..	..	..
Total	16,701	84,113	7,093	11,445	1,229

Of the 53,000 sheep imported from Hamburg, a few have appeared in fair condition; but at least nine-tenths have shown very little improvement either in weight or quality. They have made from 17*s.* to 29*s.* each. Several cargoes of stock reported from Spain, &c., have reached the outports, and some have been forwarded to the London market. The comparative statement of imports into the metropolis runs thus:—

Imports in the First Six Months.

Year.	Beasts.	Sheep and Lambs.	Cattle.	Pigs.
1862	11,462	49,332	9,459	883
1861	22,045	46,674	6,187	4,309
1860	17,193	76,415	7,965	2,492
1859	14,453	57,830	7,619	1,119
1858	7,670	20,642	7,489	250
1857	14,493	30,111	9,042	505
1856	10,444	13,587	5,265	209
1855	18,526	19,930	8,872	409
1854	22,327	38,030	9,775	637
1853	23,647	64,978	11,671	840

This comparison shows some remarkable results. Notwithstanding the important rise which has taken place in the value of meat in this country, it appears that the importations of stock from abroad have gradually declined. For instance, in the first six months of 1853, 23,647 beasts, and 64,978 sheep were reported. Last year in the same period, only 11,462 beasts, and 49,332 sheep came to hand. This year we have received 16,701 of the former, and 84,113 of the latter. Thus for the present we are rather increasing the supply, but not to an extent which is likely to have much influence upon prices.

The abundance of rough fat has produced a decline in the value of that article to 2s. 1d. per 8 lbs. This change, which has wholly arisen from the improved condition in which the stock has come to hand, has failed to have any depressing effect upon the value of meat. The dead markets have been well supplied, and a fair business has been doing, at steady rates. In Newgate and Leadenhall, beef has sold at from 2s. 8d. to 4s. 4d.; mutton, 3s. 2d. to 4s. 8d.; lamb, 5s. to 6s. 4d.; veal, 3s. 8d. to 4s. 10d.; and pork, 3s. 4d. to 5s. per 8 lbs. by the carcase.

The rapid increase in the foreign and colonial trade of the country, and the great activity which an abundance of capital has communicated to commercial enterprise, lead to the inference that the cattle trade will continue in a healthy state. The aggregate supplies of stock in the hands of the graziers may be fully equal to those of last season, and the arrivals from abroad may be extensive; nevertheless, the enormous consumptive demand must have the effect of keeping prices nearly or quite up to their present level.

4, Argyle Square, St. Pancras, London.

XXVI.—*Report of the Stewards of Stock at the Worcester Show.*

IN order to arrive at a fair estimate of the comparative number of the Worcester entries, it has been necessary to take Leeds in 1861 as our trial year; and the result is, that we can report progress in three out of the four departments of stock. The sheep entries are 91 and the pig 41 in advance, and the Hereford breeders bore up so manfully for their great white and mottle-face interest as to more than wipe off the Yorkshire majority in the horse classes.

Setting aside the purely Scottish and foreign entries at Battersea, we have 1219 at Worcester (which were contributed by 369 exhibitors) against 1595. Pursuing this comparison with "the exceptional year," we have 166 entries (14 of which comprise 11 pairs and 3 trios) against 250; 113 Hereford (including 8 pairs and 2 trios) against 97; and 50 Devon against 66. If we then disregard, and fairly enough, the somewhat wholesale and strictly speculative consignment of 23 Shetland ponies to Battersea, we have 201 horses and ponies against 233,—a diminution which is more especially due to the great paucity of Suffolk Punch entries. The very slender Ryeland reinforcement did not compensate for the absence of the Kent and the Dorset sheep, which had no special classes to tempt them; but it is also owing to the falling off in the Southdown, Hampshire, Mountain, "Lincoln, and other Long-Wools," that we find the sheep entries only 450, or 125 behind last year. The pig entries were much stronger in Berkshires; but still there was a balance against them of 38, when compared with the 194 at Battersea, where the sows were considerably more numerous.

The experience of public judging which was then gained, and the additional space available for the purpose, were turned to ample account. Instead of judging them between the rows, the cattle and the Leicester sheep were brought out into rings, and the proceedings of the Short-horn Judges were keenly watched by a large crowd for upwards of six hours! In order to make the system as perfect as possible, it might be well if the "Highly Commended" and "Commended" cards were handed out by Judges along with the prize ones, and fixed up at once by the attendant. It might also be suggested that boards should be put up to the height of 6 feet along the head of the bull-sheds, so as effectually to prevent the spectators from teasing the bulls,—a thoughtless practice, which is stated to have utterly ruined the tempers of not a few for life. Placing the cattle in double rows with such a boarded partition between them, would also tend considerably to economise space.

Professor Simonds thus reports on the general condition of the stock :—

"The whole of the cattle were free from hereditary disease, with the exception of one in the Shorthorn and another in the Devon classes, which showed a tendency to scrofula. I detected no congenital disease, except in one Shorthorn, which had a malformation of the testicles, but not sufficient to disqualify him. A few had enlarged hocks, and there were a great many cases of indigestion; but the health, as a whole, was very satisfactory, and there were no disqualifications on the ground of excessive fatness.

"The sheep were very healthy, and there were only two cases (among the Cotswolds) of hereditary disease. The excessive over-feeding of sheep is, however, leading to gravel deposits; and a Leicester shearling tup had to be killed in consequence. Many of the cases of illness arose from the over use of tares by the shepherds in attendance.

"Among the pigs (which were perfectly free from hereditary disease) more cases of false description occurred than for some years past. These came chiefly from Leeds and its neighbourhood. Some of the ten disqualifications have evidently arisen from lack of due care on the part of the large pig-owners in not keeping their litters sufficiently separate, and neglecting the system of ear-marks. The substitution of entries has been so reckless, that a sow of 10 months was sent in the place of one of 26 months; and there is reason to believe, from information received and laid before the Council, that several fraudulent entries have been made. Some of the pig-owners tore down the Disqualification-cards; and it was only on the threat of expulsion from the Yard, that they were restored to their places."

CATTLE.

The Shorthorns.—In the Shorthorn classes we missed the familiar names of Ambler, Atherton, Dickinson, Douglas, Gunter,³ Majoribanks, Stirling, and of the lamented Jonas Webb. Still the ranks were recruited by several new exhibitors, including the present owner of the "Bolden Duchesses;" and Sir Antony de Rothschild, Mr. Jacob Wilson, Mr. M'Intosh, and Mr. R. E. Oliver took maiden honours, viz., three firsts, a second, and two reserve numbers. The whole of the five entries from Warlaby (four of which were shown in pairs) were prize takers; and Colonel Towneley had a first in the local classes; and two seconds, three thirds, and two reserve numbers in the far severer contests for the Society's prizes. Some few of the animals showed in their hair and handling that absence of pure breeding which we should now have hardly expected to find in a Royal Show-yard. There was also a strong and rather universal tendency to "cushion," which this year seemed to extend itself to quite young calves; but still, on the whole, there seemed to have been less "high-pressure forcing" than usual. "General Murat" and "Marquis Cornwallis" were the only bulls, out of the 53 aged and two-year-old ones at Battersea, which put in a second appearance; and those three first prize winners, "Forth," "Whipper-in," and "First-Fruits," did not return to try conclusions once more. "Lord of the Harem," the second

prize aged bull of last year and the reserve number at Leeds, was only shown in a "Bull, Cow, and Offspring Class." This is a very popular mode of competition in Herefordshire, and calculated, like the gold medium medals of the Highland Society, to give the public another sight of old favourites which may be disqualified by having taken the first Aged Bull and Cow prizes from again appearing in a Royal Show-yard. Thus, Colonel Towneley at one time contemplated sending "Royal Butterfly" to bear his part in one of these trios; and, as it was, another species of local committee prize brought out Mr. Richard Booth's "Queen of the Ocean," the gold medal cow of last year. "Pride of Southwicke," which stood second to her in her class at Battersea, was now the first prize cow with "Maid of Athens" (who there took the first heifer-in-calf prize, when "May Morn" was disqualified) next in order. Lady Pigot has thus, for five years in succession, taken a prize in this class,—to wit, a third with "Empress of Hindostan," a third and a first (owing to the two cows above her not qualifying) with "Second Duchess of Gloucester," and a second and a first with the "Pride of Southwicke." Her ladyship's heifer-in-calf "Rosedale," which was not noticed last year, turned the tables on to Mr. Booth's "Second Queen of the May." "Rose of Bushey," the first prize calf at Leeds, was uncommended in this very fine class; and Colonel Towneley's yearling "Frederick's Farewell" made such good use of the thirteen months as to take precedence of "Lady," "Claret Cup," and "Castianira." Two of the Judges have sent in this Report:—

"We have seen a much finer class as a whole at The Royal, than the aged bulls in Class I.; but still there were some very creditable ones, not overloaded with flesh, and fit for service—a remark which applies generally to the three first classes. Mr. J. Wilson's 'Duke of Tyne,' and Mr. Charlesworth's 'General Murat' were bulls with good quality and hair, and there was a difference of opinion between the three Judges as to which should have first honours.

"Class II. for two-year-old bulls was nothing very great. It was a very near thing, indeed, between the first prize bull, Viscount Hill's 'Hetman,' a very fair level bull, and Mr. Peel's 'Hengist.' But for the protuberance about 'Hengist's' rumps, their relative places might have been reversed. The third-prize bull, Mr. J. Brown's 'Young Radford,' is deficient in his handling, quarters, and thighs; and uses his hind-legs badly. The reserve-number, Lord Feversham's 'Vice-Chancellor,' was a very useful bull, and there was much discussion as to whether he or 'Young Radford' should have the third prize.

"The Yearling Bull Class III. was not good as a whole. Mr. Eastwood's 'Hero,' the winner of the first prize, was a very even-made one throughout; and if his touch had been quite in keeping with his shape, he would have been a very superior one. There was, however, a difference of opinion between the Judges as to the relative merits of him and the second-prize bull, Colonel Towneley's 'Royal Butterfly 11th,' a stylish animal with an advantage of 10 months. The third prize, Mr. Woodward's 'French Butterfly's Cœur de

Lion,' was a large growthy bull, not very even, but with great substance and better hair and quality than any of them, besides being quite the most active on his legs, which was a great point in his favour.

"The first prize in Class IV. was awarded to Sir Antony de Rothschild's 'Captain Cherry,' a well-grown 10-months-old calf with very good hair and quality, but slightly weak in his back. There was great difficulty in deciding on a second and third out of a lot of very small promise. The second prize was eventually given to Mr. Garne's 'Pizarro,' and the third to Mr. Robinson's 'Pretor,' while Sir Anthony de Rothschild's 'Officer' was made the reserve-number.

"The female first-prize winners were very superior to the bulls, and the four along with 'Queen of the Ocean,' 'Second Queen of the May,' 'Frederick's Farewell,' and 'Lalage the 2nd,' make up eight, such as we have seldom seen together in a Show-yard. With the exception of the first-prize winner, Lady Pigot's 'Pride of Southwicke,' Class V. for cows was a very indifferent one; and the winner, a very stylish good cow, was fit to meet far better company. It was, in short, 'one first and the rest nowhere.' The second-prize cow, Mr. Lane's 'Maid of Athens,' was large and patchy; and the reserve-number, Lord Spencer's 'Veil,' very hard and with bad hair. 'Pride of Southwicke' was shown in very beautiful condition; but 'Maid of Athens' and 'Veil' were overdone.

"In the Two-year-old Heifer Class VI., the Judges were divided in opinion between Lady Pigot's 'Rosedale' and Mr. Booth's 'Second Queen of the May;' but the ultimate decision was in favour of 'Rosedale,' a heifer of very great substance, and, although five weeks younger, much the heaviest of the two, but a little patchy on the back. 'Queen of the May 2nd' was not so well up to the mark. Several in this class, including the first-prize winner, were very much overfed. After the first two places had been awarded, there was considerable difficulty in settling on a third and a reserve-number. The decision was eventually in favour of Colonel Towneley's 'Roan Knight's Butterfly' and 'Royal Butterfly's Duchess.' The former, a heifer of great substance, won her third prize at a disadvantage, as she had calved only seven days previously. Her companion was more stylish, but too high on the leg, and rather light beneath. Four other heifers, Mr. R. Taylor's 'Trinket,' Mr. E. Bowley's 'Musical,' Mr. Butler's rich roan heifer, and Mr. Lane's 'Kiss the 3rd,' were all highly commended, and most deservedly.

"The first-prize yearling heifer in Class VII. was the Duke of Montrose's 'Flower Girl,' a very fine one in every way with large size, quality, and style, and a very awkward one to meet. The second-prize one, Colonel Towneley's 'Frederick's Farewell,' was very good, and the pair were a long way ahead of the third-prize one, Lady Pigot's 'Castanira.' Colonel Towneley's 'Bampton Butterfly' was the reserve-number, and four others were commended. It was like the class above it, a decidedly good one on the whole.

"In Class VIII., Mr. Macintosh's 'Lady Oxford 5th,' a heifer-calf of most undeniable symmetry and still more remarkable quality, distanced everything. The second-prize winner, Mr. Oliver's 'Lalage 2nd,' was an even clever calf, but wanting the grandeur of the first. Colonel Towneley's 'Royal Butterfly's Pageant,' which was placed third, is a neat one of an objectionable colour, not very growthy, and rather weak on its legs. It was a very near thing between it and the reserve-number, Mr. Hegan's 'Grand Duchess 12th,' which was, however, not so symmetrically made.

"The first prize for a pair of cows in-milk was won very easily by Mr. Richard Booth's 'Queen of the Ocean' and 'Soldier's Bride.' 'The Queen' had very decidedly bettered her Battersea gold-medal form, and 'Soldier's Bride' is very drooping in her rump, but improved in her touch. For the three-year-old heifer-pairs, in which the first prize was won by Mr. Middle-

borough's, not much can be said. The first three-year-old pair-of-heifers prize was adjudged to Mr. Richard Booth for his 'Graceful' and 'Lady Joyful,' two very good heifers and not overdone. It was a good class, but won easily, and the three pairs of roans made a most effective appearance in the ring. The prize for the pair of yearling-heifers was as easily won by Colonel Towneley's 'Double Butterfly' and 'Perfume.' In the bull, cow, and offspring competition, Mr. Langston's bull 'Lord of the Harem' was decidedly superior to Mr. Stratton's 'Knight of Lagan,' but the goodness of 'Lady Hinda' and her 'Knight of Lagan' calf turned the scale."

The third Judge, who was obliged to leave Worcester before he could meet his colleagues and draw out his Report, writes thus:—

"BULLS—Class I.—'Duke of Tyne' had a fine frame, with good flesh; but did not cover well along his back and loins. 'General Murat,' when out, did not carry himself well, and was also too high on the leg.

"Class II.—'Hemlock,' a very level useful bull, not in condition, and would have been better if his frame had been larger. 'Hengist,' a bull of large frame and great substance,—a very useful animal. 'Royal Butterfly 10th,' a good bull, but uses his hind legs badly.

"Class III.—'The Hero,' a very level nice young bull, of good size for his age, which is only 1 year, 1 month, and 3 weeks, being 9 months younger than 'Royal Butterfly 11th,' who is also a good bull.

"Class IV.—A large and generally good class. 'Captain Cherry,' a good young bull with excellent hair and flesh; walks and carries himself well. He is decidedly the best bull in his class, but I much doubt whether he will train on or show so well another year, as his back already shows signs of giving way. 'Pizarro' has flat sides. 'Pretor' is a young bull of considerable promise, with excellent hair and flesh. This I consider to be the best class amongst the bulls. There were several animals of considerable promise in it, but none sufficiently good to induce me to hope that they will eventually become first-rate old bulls.

"COWS—Class V.—'Pride of Southwicke,' a well-known and very excellent cow. 'Maid of Athens,' an indifferently good cow, which would have been beaten by 'Veil,' had the latter been better in hand, a point in which she was very deficient. With the exception of 'Pride of Southwicke,' they were a very bad class.

"Class VI.—'Rosedale,' a very excellent heifer with fine frame and good flesh. 'Second Queen of the May' is also an excellent heifer, inferior to 'Rosedale,' but far superior to the rest of her class. 'Roan Knight's Butterfly' is a heifer with fine level fore-quarters, but narrow in the twist. A good class.

"Class VII.—'Flower Girl,' a very fine level heifer of good quality. 'Frederick's Farewell' also a fine and good heifer. 'Castanira' inferior to the above, and rather deficient in quality. A good class.

"Class VIII.—'Lady Oxford 5th,' a very excellent heifer, and of great promise, quality first-rate, with very good hair. 'Lalage the 2nd,' a good level heifer. 'Royal Butterfly's Pageant,' a good heifer. 'Grand Duchess 12th' is at present, perhaps, a little inferior to the above, but of great promise.

"LOCAL PRIZES.—Two good cows, but very fat; one of them a well-known and very superior cow.

"I may remark that the heifers generally were very good; probably few better animals have ever been exhibited than those which gained the first prize in each class. I regret that the cow-class was not better filled; but there are few better cows than 'Pride of Southwicke' or 'Queen of the Ocean.'"

Herefords.—It is worthy of note, in the Hereford classes, that the late Lord Berwick's blood, which was so highly successful last year, only won a second in the Bull-Calf class. The Mon-aughty herd blood of Sir Benjamin had, on the contrary, a great run of luck, with four firsts and three seconds. It is also rather a curious coincidence that the first and second winners in the Aged Bull class should have been both by "Sir Benjamin," and both bred by Mr. Thomas Rea, of Westonbury; and those in the two-year-old class both by "Carlisle," and both bred by Lord Bateman. Mr. Richard Hill did not send "Milton," his gold medal bull of last year; and "Theora," the first heifer-in-calf at Battersea, was entered, but did not compete in the Cow class. Mr. W. Perry's first prize cow "Beauty" was the first yearling heifer at Leeds. "Adela," the first prize calf at Leeds, as well as the first prize yearling heifer at Battersea, was only a reserve number; while "Adelina," her half-sister, and the first prize calf at the latter Meeting, was not even mentioned. "Battersea" had also to succumb to "Adforton," who was third to him in the Bull-Calf class of last year. The victory of the octogenarian blind breeder Mr. John Monkhouse, of The Stow, near Hereford, with his first prize yearling heifer "Clementine," deserves more than a bare mention in the list of awards, as he is nearly if not the oldest living exhibitor at the Society's Meetings.

One of the Judges reports as follows on behalf of himself and his colleagues:—

"The Old Bulls (Class IX.) were short in number, but a good class. The first prize was awarded to Mr. J. H. Arkwright for his 'Sir Oliver the Second,' with firm flesh, great size, and very fair form; and the second to Mr. T. Davies, for 'Plato,' a bull of better quality than the first prize, but with one or two points about him a little deficient. Both these were bred in the herd of Mr. Rea of Westonbury, which has long been noted for combining great size with good quality.

"Class X. contained a very good lot indeed of bulls, and we had some trouble to select the winners from them. The first prize went to Mr. W. Taylor, for 'Tambarine,' bred by Lord Bateman, an animal of size, substance, and quality; and the second to Mr. W. C. Morris, for his 'Moderator,' also bred by Lord Bateman, a bull with a good back and fine length, but not the style and quality of the first-prize one. The third prize was awarded to Mr. H. R. Evans's 'Rodney,' a compact bull whose colour was good, but whose hair prevented him from being placed any higher. 'Victory,' shown by Mr. Duckham, had rare hind-quarters, but was deficient forward, which prevented his being noticed. This was indeed a good class.

"Class XI. contained 15 yearling bulls, and among them many of the cracks of the last season. The first prize was given to 'Adforton,' bred by Mr. Tudge and shown by Mr. Edwards. He was of fair size, great substance, and a credit to the herd. The second-prize bull was Mr. Baldwin's 'Battersea,' the prize-calf of last season, and expected by many to be at the head of the class; but he has trained off, and is certainly not so good a bull as we hoped to have seen him. The third prize was given to Mr. E. Tanner, junior's, nice hind-quartered bull 'Ballarat,' whose shoulders were far from what they ought to have been,

or he would have been better liked. A very good class indeed, and with the most merit of any.

"Class XII.—Bull calves, and a rare lot too. First prize to Mr. Roberts, for a very nice one, with plenty of hair and quality, but perhaps not quite so good a back as the second-prize one; but such thighs for a young one as are not often seen, with just the style and character which a Hereford calf ought to have. The second prize went to a nice young bull, Mr. R. H. Capper's 'Worcester,' with a rare back, but not the quality of the first prize. Mr. E. Wright's 'David' and 'Lion' got the third prize and the highly commended card. They were a nice pair, and could hardly be parted.

"The Cows (Class XIII.) were a grand lot. The first prize was given to Mr. Perry of Cholstrey, for a 'Beauty,' and a type of what a Hereford ought to be, with a calf of a few days old by her side. She went to the fore, and soon distanced all competitors. Still, she was well supported by 'Kate,' another good one of Mr. Rea's, for second prize; and Mr. Duckham's 8½-year-old cow, 'Delight,' of famous size, excellent quality, and not loaded with flesh, showed in good form and breeding condition. I must commend the owners of these animals for resisting the temptation to make them any fatter. There were some more good animals in this class, but those placed and named were quite ahead of the rest.

"Class XIV.—The first prize was awarded to Mr. W. Tudge for a thick, small heifer, 'Lady Ashford,' with not a nice forehead, but the most perfect in her class; and the second to Mr. Pitt, for a nice heifer of her sort, but not good in her colour, and her touch hardly what it should be. General Wood's highly-commended heifer, 'Adela,' has splendid hind-quarters, and is likely to do some good in a herd, if put to the right sort of bull. Mr. T. Thomas's 'Laura' and Mr. J. Williams's 'Duchess' were passed over, principally on account of being too fat for breeding, and more fit for the shambles. One of them, a prize-heifer last year, was completely spoiled by overfeeding; and it is to be hoped that her owner will give up this practice.

"Class XV. were a nice lot of yearling-heifers; old Mr. Monkhouse going ahead of all the rest with his 'Clementine,' a heifer of good size, substance, and quality of the right sort. She was backed up by a thick one of Mr. Roberts's, 'Second Duchess of Bedford,' perhaps the most complete of the two, but never likely to make so good a cow. Mr. William Perry got the third prize for 'Lady Duppa,' as true in form as anything in the classes, but not quite right in her hair, and too small to be placed higher. The Hon. T. H. Noel Hill's good heifer, 'Petunia,' was highly commended.

"Class XVI.—Mr. Roberts had the first prize for 'Miss Hastings the Second,' a useful calf and no more. The second was awarded to Mr. Knight's grey calf, 'Lady Jane Grey,' a very nice little thing. This was the weakest class in the lot."

The Devons.—These classes fell off sadly in point of numbers. The names of Davy, Halse, and Quartly did not appear once among the entries, and Merson only once. The classes were indebted for just a tenth of their numbers to the Royal Norfolk Farm, where the yearling bull-calf "Prince Alfred" (the solitary instance in the three leading cattle classes of a first prize winner of last year holding its position) and "Rose of Denmark," the first prize heifer calf, were both bred. The first prize cow, "Rachel," bred by Lord Portman, stood third at Battersea. Mr. George Turner made eight entries, and his blood won two firsts and two seconds. "Viscount," who now girths

7 feet 10 inches, and took first prizes both at Leeds and Battersea, just failed to complete his honours.

One of the Judges thus reviews the classes :—

“Class XVII. (Aged bulls.)—There was not one first-class animal in this class. The first-prize one, Mr. S. Newbery’s ‘Prince Jerome,’ was rather a nice bull, with very good quality, but not a good head. The second-prize bull, Mr. W. Farthing’s ‘Viscount,’ was a very deep-fleshed bull, but had not the character of a true North Devon, although a very useful one to get steers.

“Class XVIII.—Only two entries, and although we did not like to withhold the prizes, we considered both the young bulls, Mr. J. S. Surman’s ‘Van Tromp’ and Mr. J. Merson’s ‘Fusilier,’ very inferior animals.

“Class XIX. a better class, and containing several yearling-bulls of considerable merit, especially General Hood’s ‘Prince Alfred.’ He is a most promising young bull, and won the first calf-prize at Battersea last year.

“Class XX.—Nothing very choice among these bull-calves; but it is a difficult age to judge. The class, which was headed by Mr. George Turner’s ‘The Drone,’ was by no means so good as at Battersea.

“Class XXI. a remarkably good class, with many cows of great merit, and not one bad one among them. The first prize was awarded to Mr. J. A. Smith’s ‘Rachel,’ one of the best specimens of the true North Devon that I ever saw, and in my opinion the best animal in the Show-yard. The second-prize cow, Mr. W. Farthing’s ‘Cheerful,’ was a very heavy deep-fleshed cow, and a very good one indeed. There were 4 high commendations, and the class was generally commended.

“Class XXII.—There was only one good heifer in this class, Mr. C. Hambro’s ‘Lina,’ which took the first prize. She was a remarkably good specimen, but all the others were below mediocrity.

“Class XXIII.—Nothing very choice, but the first and second prize yearlings, Mr. J. W. Buller’s heifer and Mr. G. Turner’s ‘Devoniensis,’ were rather promising.

“Class XXIV. was a good class; the first and second prize calves, General Hood’s ‘Rose of Denmark’ and Mr. George Turner’s ‘Lady Audley,’ were very good, and it was a very near race between them. Several others were very promising, and two were highly commended.

“To sum up. It was a very good show of Devons, considering that three of the most important breeders, viz. the two Quartlys and James Davy, did not exhibit a single animal. The bull-classes were decidedly inferior to the female ones.”

Sussex and other Established Breeds.—Last year 30 Sussex cattle were sent by 11 owners to compete for the 80*l*, whereas now only 14 came to Worcester from 5 different herds. In fact, so scanty were the entries that two second prizes were not claimed at all. The Messrs. J. and A. Heasman, who have consistently supported these classes, took three firsts and two seconds. The aged bulls in the “other Established Breeds” were placed thus :—“Melcombe” (the first prize long-horn yearling at Battersea), a Welsh bull, a Jersey, and a Suffolk. In the Yearling Bull classes, the first prize was given to a Suffolk over a Jersey; and in the three female classes, with the exception of a third to a Jersey, all the prizes and the reserve numbers went to Norfolks and Suffolks, the property of Lord Sondes, Sir Edward Kerrison, and Sir Willoughby Jones. Although the Suffolks this year had

no special 80L in prizes, the entries of them amounted to 22, or only 5 less than at Battersea. Hence their claim to form a separate class is quite equal to that of Sussex. One of the Judges thus reports on these classes :—

“The Sussex cattle were badly represented; for although the Society offered ten prizes, amounting to 75l., in five classes, there were only 13 animals, viz., 5 bulls, 4 cows, and 4 heifers exhibited. The bulls were deficient in form and quality; but the cows and heifers indicated that more care had been shown in the selection and management of them, and their milking points were very apparent. It is much to be regretted that more attention is not paid to form and quality in the selection of Sussex bulls; but the coarse shoulders and the hard thick skin of the working ox seem to be the chief merits in the eyes of many. Some of the animals exhibited showed decided indications of the use of Devon blood. This may do good, if properly managed; but great care should be taken that in attempting to obtain more flesh at an early age, this breed, so useful for its own district, be not deprived of its milking qualities and its hardy constitution.

“*Other Established Breeds.*—Under this head the Society offered 14 prizes, amounting to 75l., and 4 silver medals. The Judges had great difficulty in making their award in some of the classes, in consequence of the various breeds entered for competition being not only dissimilar in character, but specially adapted to different climates and soils. I annex a tabular statement of the number of the several breeds exhibited in each class in this department :—

	CLASSES.					
	30.	31.	32.	33.	34.	Total
Norfolks ..	2	1	4	2	4	13
Suffolks ..	2	0	1	2	4	9
Longhorns ..	2	0	0	0	0	2
Welsh ..	1	0	3	1	0	5*
Jersey ..	2	2	5	4	1	14
Guernsey ..	1	1	3	4	0	9
Breton ..	1	2	7	7	1	18
Ayrshire ..	0	0	0	3	0	3*
	11	6	23	23	10	73

“The two Longhorns were moderate specimens of that almost extinct breed. The Pembroke were the only Welsh cattle exhibited, and the cows possessed size, constitution, and good milking points. The Polled Norfolks were exhibited in good form and condition, evidently showing that more attention is now being paid to their feeding properties and early maturity; but some of them appeared deficient in milking points, and there are traces of this breed having been crossed with the Poll Angus at no very distant period. The Suffolks were generally good; their milking characteristics were very conspicuous, and No. 334, the nine-year-old ‘Duchess of Suffolk,’ belonging to Sir Edward Kerrison, was a grand specimen of what a cow should be. The three Ayrshire cows were not fair types of that useful breed for dairy purposes. The Jerseys (commonly called Alderneys) were not generally good specimens of that valuable breed for the production of butter, most of them having been

* There were also a bull and cow of each of these breeds in the extra classes.

sent there for sale. There were, however, a few exceptions. No. 322, a grey bull, 'St. Helier,' exhibited by Mr. Dumbrell, of Ditchling, Sussex, was of beautiful form and character; and so was No. 352, the cow 'Lavender,' belonging to the same gentleman. Nos. 368 and 369, Mons. Albert le Gallais' heifers in-calf, 'Jersey Lass' and 'Daisy,' possessed most of the points which are considered requisite for the production of butter. The Guernseys were few in number, and require no particular remark; but No. 339, Mr. Richard Cowan's cow, 'Annie,' was a good specimen of the breed. The Bretons are very small and so unfit for general use, that they can only be looked upon as 'pets' for small enclosures. There was, however, one exception, No. 347, the Rev. J. H. Gandy's 'Battersea,' a cow in miniature, possessing great milking points, with superior form and quality of flesh.

"It will in my judgment be very desirable for this Society to have separate classes for milk-producing breeds of cattle, and especially for the breeds of the Channel Islands, which are becoming much sought after and appreciated."

HORSES.

The horse-ring parades were again an immense attraction at 11 and 3 each day, and the boxes were remarkably complete and good. Fourteen blood sires were entered for the 100l. prize, and, for the first time, the whole class was highly commended. The Judges acted on the sound principle that "action carries weight," when they added "Neville" to the list of the Society's thoroughbred winners, which contains, within the last ten years, the names of "Loutherberg," "Royal Ravenhill," "British Yeoman," "Hobbie Noble," "Spencer," "Hunting Horn," "Dagobert," "Nutbourne," and "Ellington." There were no less than 21 entries for the hunting sire prize, but many of them were so crossbred and unsuitable for the purpose that it might be well to consider whether any horse should be eligible to compete which has not at least three thoroughbred crosses in his pedigree. A more stringent rule might exclude some very valuable hunter-getters. If a thoroughbred qualification had been insisted on in this class, it would have barred "Elcott" (who is within an ace of being thoroughbred), and "Safeguard," the very clever third prize horse as well. "Sir Peter Laurie," the first in this class, was a great winner over the Worcester, Cheltenham, and other steeple-chase countries in his day, and second to "Hunting Horn" for the original thoroughbred prize at Warwick. Some of the class appeared to be orthodox coaches, and others between a coacher and a Norfolk cob.

The generally commended Hunters' class was a very great improvement upon Battersea, and was won by Mr. John Booth's five-year-old "Beechwood" (by a son of "Launcelot"), who was then the reserved number. He has "gone on" wonderfully since, and has become a most successful winner at Hunter shows. The mare which took the second prize was by "Ted-dington;" and her half-brother by "Charles XII.," and a chesnut

gelding by "Hereford," from a Steamer mare, were highly commended. "Equal to 15 stone with hounds" was rather a high standard, and a few of the candidates looked as if they would have not got very near the hounds under it with an afternoon fox. The 14 entries of hunter brood mares were 4 in advance of last year, but not so good as we hoped to find them; and "Tom Sayers" was nearly as great a feature of the pony sires under 14 hands as his sire "Highland Laddie" was at Chester, or old "Bobby" at Battersea.

The Judges for thoroughbred sires have reported thus:—

"Class XXXV., for Thorough-bred Sires, may be considered the best that the Society have had. The first and second prizes were awarded to 'Neville' and 'Cavendish,' animals well calculated to answer the purpose for which the prize is offered.

"In Class XXXVI., for Hunter Sires, the Judges experienced some difficulty, owing to the mixture of hunters and hacks, and they consider that the former plan of dividing these horses into two classes is preferable. The first and second prize horses in this class, 'Sir Peter Laurie' and 'Elcott,' were well calculated to get hunters, and the third prize, 'Safeguard,' was a good specimen of a hunter himself.

"In Class XXXVII., for Hunter Brood Mares, no animal, with the exception of the first prize, Mr. John Watson's 'Lalage,' was quite well enough bred to merit any high encomium.

"In Class XXXVIII., for Hackney Brood Mares, the first prize was awarded to Mr. H. Percy's 'Crafty,' a very clever hack, and a true type of her class. Mr. Samuel Walker's 'Polly' was next; but the class was very short.

"Class CII., for 'Hunters exceeding Four Years-old, and equal to Fifteen Stone with Hounds,' was very strong in numbers, and contained many animals of considerable merit. The first prize, 'Beechwood,' was equal to great weight; the second and the highly commended were animals possessing much quality and style. The whole class was very satisfactory, and much better than we have ever seen, except at Leeds."

One of the Judges further observes:—

"'Neville' is the best mover I almost ever saw in my life; he has the greatest freedom of action, and steps the truest. With this he combines really good hind-leg action, and withal his body is quite still—no rolling about, and his every movement is graceful and easy. He has had an enlargement under the jaw and at the side of his neck, unluckily on the near side, which makes his head and neck look coarse at first sight to a casual observer, but by a judge the defect is at once seen and forgiven. He only wants rather bigger fore-legs to be all you require in a horse to get hunters, being long and low, with big girth, action, quality, and size enough for anything. 'Cavendish' was a nice fresh wholesome-looking horse, but with neither the action or well-formed fore-legs of 'Neville'; but still he is a very useful horse and likely to get good stock. 'Cambondo' had better formed and bigger limbs than either, but he is light in his back ribs and irritable in his temper. Altogether the blood stallions exhibited were an improvement on former years.

"The Hunters were more numerous and better-looking than I ever saw them at any previous meeting: the only thing wanting was a little more power. The quality and shape of most in this class was very good. The brood mares, on the whole, were not good.

"HACKNEYS AND PONIES.—The Judges are of opinion that Class CIII. (Three Year-old Geldings or Fillies for Hunters or Carriage Horses) is a very

good one, the horses in it combining size and quality. Class CIV. (for Two Year-old ditto) is also good, and Class CV. (for Cobs not exceeding 15 hands or six years-old) decidedly below the average. Class XXXIX. (for Pony Stallions not exceeding 14 hands), though small in number, is decidedly good; the winner, Mr. J. Moffat's 'Tom Sayers,' being an excellent specimen of the pony cob. Class XL. (for Pony Mares not exceeding 14 hands), is on the whole a satisfactory one."

Agricultural and Dray-Horses.—These classes were very nearly equal in point of entries to those of last year, but there were no claimants for 35*l.* out of the 120*l.* offered for the latter, as only one mare and foal came, and no two-year-old fillies. The flower of this part of the Show was the grey "Young John Bull;" and the Judges, after trying him in every way, were quite unable to endorse the opinion of Professor Varnell that he was a roarer. In the Agricultural classes, the majority of the prizes stayed in Worcestershire and the adjacent counties, which had hardly value received for their very liberal 40*l.* and 20*l.* prizes for the "best stallion (Suffolk breed only excluded) to travel in the district."

The Judges report thus on the two classes :—

"*DRAY HORSES*—Class XLV. (Stallions).—Mr. T. Johnson's 'Young John Bull' is a very first-class animal, and we consider him well worthy of the first prize, notwithstanding the remarks of the Veterinary Surgeon. The second-prize taker, Mr. W. H. Neale's 'Prince of London,' is a useful colt, but the remainder are bad.

"Class XLVI. (Two-year-old Stallions).—The first prize, Mr. C. Morrison's 'Basildin,' is also a useful colt.

"Class XLVII. (Mare and Foal) only one very moderate animal entered.

"Class XLVIII. for Two-year-old Fillies had no entry.

"*AGRICULTURAL HORSES (NOT SUFFOLKS)*.—Class XLI. a moderate class.

"Class XLII.—The first-prize colt (Mr. W. Coney's), good; but the class generally very moderate.

"Class XLIII. (Mares and Foals) a poor class.

"Class XLIV.—The first and second prize two-year-old fillies, Mr. Charles Friday's 'Flower' and the Hon. Colonel Pennant's 'Matchless Grey,' are useful animals, and the remainder bad.

"Class CVI. for the best Agricultural Stallion to travel in the district, only two animals shown, and those bad."

Suffolks.—It may have been that the owners of Suffolks did not care to seek a county which had declared so openly against their breed, or had taken their best specimens to Hamburg; but, at all events, the entries fell from 62 to 20. The dispersion of the stud of Mr. Barthropp (who acted as one of the Judges) had its share in weakening the ranks, and we might well look back to the "cherry-red" treat of last year, when "the 13 two-year-old fillies and the 26 sires, with only one white face amongst them, were on their parade." Sir Edward Kerrison's brood mare "Bragg" was the queen of the lot, and will be remembered as the first prize two-year-old filly at Warwick. The Judges thus review their labours :—

"Class XLIX. (Stallions).—One entry and that not first-class.

"Class L. (Two-year-old Stallions).—A fair class, but we have seen much better.

"Class LI. (Mare and Foal).—But one shown, Sir Edward Kerrison's 'Bragg'; she was very good.

"Class LII. (Two-year-old Filly).—The first and second prize takers, Mr. J. Ward's 'Briton filly' and Mr. W. Biddell's 'May Bird,' very good; but the remainder very moderate."

Professor Varnell thus reports upon the soundness of the Horse classes :—

"I cannot refrain from congratulating the Royal Agricultural Society of England on the success of its efforts to exhibit horses free from diseases, and more especially those of an hereditary nature. I find from a comparison with the reports of the state of soundness of horses in previous years, that the percentage of disease of this character is very much reduced. Taking the horses as a whole, I have not been able to detect more than 6 per cent. that are affected with diseases of a serious nature, or such as in my opinion are liable to be transmitted to their offspring. These affections consist chiefly of 'roaring,' 'whistling,' ophthalmia, 'ossified lateral cartilages,' 'ringbones,' and 'spavins.' Osseous deposits upon the legs, termed 'splints,' are, as most likely they always will be, much more numerous than the other affections alluded to; but, nevertheless, they are of minor importance. A tendency to certain affections, such as 'curbs,' thickened tendons and ligaments, arising from defective conformation, exist in a few instances; while lesions of an analogous kind, together with bursal diseases of the joint (chiefly in aged horses) are more numerous.

"Among the Thoroughbreds, only 2 cases of roaring were observed, and there were only 2 horses whose limbs were affected with spavin and curb, sufficient to disqualify them from competition. In the Hunter and Hackney Classes, I found only 2 roarers; but diseases such as splints, spavins, and bursal affections, were prevalent. It is gratifying to observe that the hunters are remarkably free from disease. No case of defective respiration was noticed, and their legs and feet, as a rule, were very sound. In the Agricultural Stallion Classes, I detected only 1 roarer; and although cases of ossified lateral cartilages, flat fore-feet, and bursal diseases of the hock-joints existed, still they seem not very numerous. Among the Dray Stallions there was only 1 case of roaring, and with the exception of 2 or 3 cases of flat feet (a tendency which it is highly desirable to get rid of by careful selection both of sire and dam), these horses are free from disease of an hereditary nature. The Suffolk stallions are also very free from disease, and their feet, to which objections have been raised on former occasions, are very good. I would, however, direct the attention of breeders to the smallness of the fore-legs of these horses below the knee. With reference to the Ponies, their exemption generally from disease of an hereditary nature renders it unnecessary that I should further allude to them. I may be permitted, however, to express my opinion that the absence of disease as affecting the horses exhibited at the Society's Meeting, during the last year or two, and this year in particular, is in a great measure to be attributed to the examinations instituted by a local Veterinary Surgeon previous to their being admitted into the Show-yard; and I feel persuaded that if this system is encouraged, still greater improvements will be effected. Several cases of colic took place among the Cart-horses, owing, I have no doubt, to the large amount of tares that are given to them. I would suggest to the Society, that the quantity allowed to each horse daily should be reduced on future occasions."

SHEEP AND PIGS.

Mr. Dent, the Steward for this department, reports as follows:—

“Worcester may be fairly congratulated on having had not only a very numerous but a very excellent show of sheep. I expected to see the Shropshires, the Cotswolds, and the Oxford Downs in force so near their special localities; but we had also both Leicester and Southdown classes very numerous filled, and of more than average excellence. And first, a few words as to public judging. Several rings, of good size and easy access, were provided, into which it had been intended that every sheep should be brought to the Judges, who would thus have been quite separated from the public; but the numerous entries in several classes—as, for instance, 53 Cotswold, 61 Shropshire, 44 Leicester, and 38 Oxford Down shearling rams—rendered this almost impossible, unless a very much greater staff of labourers were employed; and in most cases the Judges preferred examining the sheep in the pens, and then selecting certain animals for the ring. There were, however, owners of sheep whose eagerness could not be repressed, and it is quite impossible for the Steward of Stock and his assistant to be present with each set of Judges. Could the plan be pursued of bringing out every sheep into the ring, and keeping the Judges there until their decision has been made, I should like it better; but this would require a very great staff of labourers, for there were at one time 177 shearling sheep being judged by four different sets of Judges. To bring the pigs into a ring would be impossible, for some of them could not even walk from their crates to their pens; and their state of fatness, and consequent immobility, would have been ludicrous, were it not distressing to the animal and a positive injury to its breeding capacity. It was certainly absurd to see a man sitting beside his pig, and holding up its head to enable it to take its supper.

“The more I saw of the Show, the more I felt that the Society should try to grapple with the shearing question. It was suggested to me that the Judges should have power to order any particular sheep, whose shape might puzzle them, to be shorn, in order to see whether the carcass corresponded with the symmetrical outside; but this would, I fear, very much lengthen the proceedings. This year was the first in which I was admitted to the mysteries of the toilette of the sheep, and certainly no young lady going to a Drawing-Room could have more pains bestowed on her than had some of the rams. The clipping and trimming during Friday and Saturday was incessant, and resulted in some charming models of symmetry. How far the carcass

would correspond with its outer garment better judges than myself can decide; but, whilst fat overloads and injures our short-horns and other horned stock on the one hand, on the other the sheep has not only fat but wool of an indefinite age to disguise his deficiencies and to heighten his graces. I should think that many of the sheep had never been truly and fairly shorn, and this was more especially the case, as it seemed to me, in the Oxfordshire Down classes: and I could not help regretting that the close-shorn, well-framed sheep of Mr. Charles Howard were not thought good enough for a prize. This delusive shearing belongs more or less to every class, many of the Cotswolds and Shropshires being glaringly conspicuous. The Shropshire and Oxfordshire Downs, though thoroughly useful sheep, have not got that degree of uniformity which makes judging easy, and until there is more fixity of type complaints are sure to arise as to judging. The Judges, on the present occasion, seem to have gone mainly for size, and, I was assured by some Shropshire breeders, had mistaken the type. Among the Oxfordshire Downs there was still more variety of appearance.

"In the Leicester Aged class, I could not help rejoicing to see the blood of the late Sir Tatton Sykes holding its own, as the first prize sheep was by a ram bred by him. The local prizes did not produce much competition, although some of the mountain sheep were very good. Mr. Peel's pen of Lonk shearlings was especially so. Looking to the great extent of mountain-ranges fitted for sheep, I think the Society should do more towards the improvement of this breed; and I trust that Newcastle may show us what the Cheviots can do in competition with other mountain sheep. But certainly, if the Lonks be as hardy as they are good, they must be the most valuable sheep for the hills that we have at present. Sheep which at 14 months old will clip 10 lbs. of wool, and which are also full of good mutton when fat, are dangerous competitors for the Southdowns and other lowland breeds. The above clip only applies to sheep like the Show sheep. The average clip of Mr. Peel's flock this year was 6 lbs., sold at 50s. the tod, and the breeding ewes and shearling rams ran on the hill-side pastures as they liked. His prize shearlings at Battersea clipped over 10 lbs. of wool each. The wether lambs of this year made 15s. each in the middle of June. In the prize pen are twin sisters, and perhaps the finest of the lot, to use the shepherd's phrase, is "a twin of three," the two brothers having been sold as tups. No doubt the mountain sheep in the Show-yard have had their share of the good things of this life, and probably done as well as the successful sheep of a noble lord, who told me that his sheep had 'everything they wanted—mutton-chops, if they liked.' But, however well kept, Lonks are, I think, a class of sheep which may very much im-

prove both the Scotch and Welsh breeds, and considerably increase the value of the mountain-ranges or sheep-walks.

"In the Pig classes, I regret to say that the Veterinary Professor had good reason to believe that attempts were made to obtain the prizes of the Society by illegitimate means, and that the state of dentition of many animals but little corresponded with their professed age. The conduct of certain disappointed exhibitors in removing the notices of disqualification which had been affixed to their pens, may render it necessary for the Council to adopt severe measures to prevent their Stewards being set at defiance. There is too good reason to suppose that the men who rendered themselves conspicuous by their impertinence in these cases were well aware of the erroneous description of their pigs, and only anxious to secure a market for their animals."

Leicesters.—The 72 entries of Leicesters were 1 short of last year, but decidedly superior both in wool and substance. Mr. Borton was in great force with his rams, and his third prize one was Mr. Sanday's third prize shearling at Battersea, where Mr. Borton did not exhibit. Lieut.-Colonel Inge took the other two firsts with the blood of Mr. Sanday, who was second and third to him in both instances. With the Worcester Meeting Mr. Sanday's career closes as a breeder and exhibitor in this class of sheep. He commenced at Northampton in 1847, and took a first for shearling ewes. In 1856 and 1858 he did not exhibit at all, and in 1854 there were no prizes. Although he has not always exhibited in every class, he has won during those fourteen years 8 firsts, 9 seconds, and 6 thirds for shearlings; 7 firsts, 8 seconds, and 4 thirds for old rams; and 11 firsts, 10 seconds, and 1 third for shearling ewes; besides 18 "highly commended" and 15 "commended." In five of these years he gained all the first prizes.

The Judges have sent in this Report on the classes:—

"Class LIII. (Shearling Rams).—A very good class.

"Class LIV. (Rams of any other age).—An average class, with some very superior sheep.

"Class LV. (Shearling Ewes).—A very superior class, and some of the pens the best we have seen for some years."

The *Cotswolds* numbered 82, or 8 fewer than last year. Mr. Robert Garne, who won nothing at Battersea, had all the three shearling honours to himself in a class of 53 (in which nothing but the prize takers were mentioned), as well as the third prize for ewes and the first prize for rams in a class which was "generally highly commended." Mr. William Garne, who was first with his shearling in 1862, got no prize; and Mr. William Lane, who had 2 firsts, a second, and 2 thirds on the same occasion, took only a second prize. Such are the uncertainties of the Show-yard! The first prize shearling was rather better in

his girth than the second, which had, perhaps, as good a fleece and more of the old Cotswold blue face, with ears nicely set and a very characteristic eye. Mr. Beale Browne was second in the splendid class of 18 rams; and Mr. E. Handy (who was second in the Shearling Ram class of last year) took third honours again. The shearling ewes were like the shearling rams, not so large as we have seen them. Mr. Fletcher's first pen were very "mouldy," but hardly big enough; and the second (Mr. W. Lane's) larger, but less correct in form.

Lincolns and other Long Wools—This class, which was divided into two at Battersea, with separate prizes, was now united again, and sank, owing, in a measure, to the absence of the West Derehams of Mr. Hugh Aylmer (who officiated as one of the Judges) from 50 to 33. Two firsts and a second in the Ram classes went to Mr. Lynn (who won all three shearling prizes last year) with his Lincoln-Leicesters: "Battersea Royal," his first prize shearling being his first prize ram at Worcester. These sheep were not too fine, and had been very carefully bred, so as to unite the form and quality of the Leicester with the size of the Lincoln. The winning pens of shearling ewes were all Lincolns; but they were not very remarkable, as this breed leaves its great value on the clipping-boards, and cannot be got up well before September. The 33 entries were made up of 19 Lincolns (precisely the same number as at Battersea), 13 Lincoln-Leicester, and 1 Cotswold-Leicester.

The *Oxfordshire Downs* entries (60) were only 2 below last year. Mr. Charles Gillett, who then won all the first prizes as well as the second and third for shearling rams, was now first for the shearling ewes and second for the shearling rams. Mr. John Bryan, who did not show at Battersea, was head in a class of 38 shearling rams; while Mr. George Wallis, who had no Battersea mention whatever, won all the prizes for rams. The Judges report on them as follows:—

"Oxfordshire Downs. Classes LXII.—IV.—This very useful and paying kind of sheep was well represented in every class. They were all good animals, combining great size with heavy wool, good symmetry, and that naturally thick flesh which indicates hardihood of constitution, and which the butchers rejoice in. At present they do not as a class show that uniformity of character which we expect to find in breeds of older date, but if the flocks of different breeders vary in this respect, still more do the owners vary in their treatment of the animals exhibited. While many have been fairly shorn, others have lost only just so much wool as was necessary to cut them into correct form. Let us hint to these exhibitors that the practice carried to such an extent defeats its object, and has a tendency rather to prejudice the judges against those animals which have been so preposterously treated. The sheep are good; they may be safely left to make their way, both with the judges and the public, if trusted by their owners to do so on their merits."

Southdowns.—The number of entries in this very favourite class fell from 96 to 70: a deficiency which was principally seen

in the Shearling Ram class, which was 17 short of its last year's mark. Lord Walsingham, who had two seconds and a third at Battersea, came out and swept the board, with the exception of the second and third Shearling Ewe prizes, besides getting three "highly commended." In fact, nothing but the Merton flock had any mention at all in the Shearling Ram class. The second prize for shearling ewes went to Messrs. J. and A. Heasman. The Throckmorton flock, which furnished the first prize pen last year, has been sold off, and the Hove and Coleshill flocks were both singularly unfortunate, when we remember their achievements at Battersea. Subjoined is the Report of the Judges:—

"Class LXV. (Shearling Rams).—The first, second, and third prizes were won by Lord Walsingham. The first prize sheep was a very fine sheep, and so was the second, but his head was not quite correct. The third was also a good sheep, but not quite right in his back and shoulders. The reserve sheep was also Lord Walsingham's. It was generally a very good class, but 3 sheep were disgraceful.

"Class LXVI. (Rams of any other age).—This was also a very good class, and the three first prizes were awarded to his Lordship, as well as the reserve, and a high commendation.

"Class LXVII. (Shearling Ewes).—This was a remarkably good class. Lord Walsingham's first prize pen was very uniform, and remarkably good. The second pen (Messrs. J. and A. Heasman's) had very good character, and the third pen (Mr. J. J. Farquharson's) were of fine quality, but too delicate. The reserve pen (Lord Radnor's) had not quite a good touch, and the Duke of Richmond's, which were also highly commended, were a little lacking in character."

The *Shropshires* were at the head of the poll, but still 3 below the 95 of last year. There were 65 in the Shearling Ram class. Here again we had a proof of the chances of war, as Mr. J. Stubbs, who was not even commended at Battersea, now took the first prize, beating the 1862 winner, Mr. Horton, in a class which comprised 1 highly commended (special), 5 highly commendeds, and 2 commendeds. Mr. Pryce W. Bowen, who was second in the Aged Ram class last year with "Patentee 4th" to Mr. T. Horley junior's "Havelock," was first this year with a younger sheep; and the first shearling ewe prize awards were exactly the counterpart of last year. Messrs. J. and E. Crane, in the first two places, and Mr. H. Matthews in the third. The Judges write of them thus:—

"SHROPSHIRE. Classes LXVIII.-LXX.—The energy which characterizes the breeders of this valuable sort of sheep was signally manifested on this occasion. The largest entry of all the breeds exhibited, and the closest competition combine to prove how strenuously the Shropshire men are endeavouring to improve their favourites, and they are proceeding in the right direction. The sheep shown on this occasion proved, with very few exceptions, that the owners are keeping in view the qualities which have brought them into favour, viz. the capability of producing a great weight of good mutton when heavily stocked upon good land. Probably no breed of sheep of equal size will bear to lie as thickly on the ground, and the increased size which the Shropshires on this occasion possessed will add to their value in public

estimation, will not diminish their power of bearing hardship, but increase their marketable value. Without particularising the winners, we may point to the prize sheet as indicating the animals which, among a very good lot, were specially distinguished."

HAMPSHIRE AND OTHER SHORT WOOLS.—Quality was needed to make up for numbers in this class, in which the previous winners found a very formidable rival in Mr. James Rawlence, who never showed in these classes except at Salisbury. Mr. Humfrey took a first and second for shearling rams, and the second ram prize; Mr. Rawlence getting the first in that class, and the first, second, and highly commended (special) for his pen of shearling ewes. The latter was a very remarkable class, as there were only eight entries, and the four other high commendations fell to those eminent prize-winning breeders, Messrs. Shittler, S. King, W. B. Canning, and W. Humfrey. The last-named gentleman and Mr. Rawlence were the first who set to work in good earnest to improve the old Hampshire breed, which originally was celebrated only for its big head, long ears, and thin-fleshed back. The success attending their efforts has been shown in the high prices which rams of this breed have realised at auctions in their district for ten or twelve years back. The judges report thus :—

"Classes LXXI.—III. numerically were not strongly represented, but in point of quality they may safely be said to be the best lot ever seen together. The shearling rams were good, but eclipsed by the older sheep, and the shearling ewes were most extraordinary. In neither class were those enormous heads and upright shoulders to be found, which formerly prevailed so much among the Hampshire sheep. All were level in their character, form, and wool, and in fact with such general uniformity, that they might have all come from the same flock. Each of the non-winners in the class of shearling ewes received, as they deserved, a high commendation."

They then add, speaking generally of the classes which came under their inspection :—

"We are strongly of opinion that all these classes of sheep are in their 'right places.' The *Oxfordshire Downs*, bred upon land of the same character as the Cotswold Hills, are, like the sheep from that district, of great size, and having been thickened both in flesh and wool, and strengthened in constitution by the mixture of Hampshire blood (which originally founded the Oxfordshire Down), will produce as much wool and mutton per acre as such land can be made to grow. The *Shropshires* upon the rich and heavy land of the Vales have this peculiar merit: they will stock thickly, and bear the somewhat severe treatment which the occupiers of the strong arable lands must subject them to, in order to produce the greatest quantity of wheat. For be it remembered, that wheat equally with mutton and wool is kept in view in the treatment of animals, and no breed of sheep will bear pinching for the purpose of preparing the land for wheat, or recover more quickly from it than the *Shropshires*. They are very prolific, good mothers, and soon fit for the market. The *Hampshires* are also at home on their native downs, and whether their produce are slaughtered as lambs, or sold to be wintered on better land elsewhere, there are none in greater favour both with the butcher and consumer."

RYELAND AND WELSH, OR OTHER MOUNTAIN BREEDS.—Only five shearling rams and two pens of theaves were entered from three flocks, and the two prizes were won by Mr. J. B. Downing of Holme Lacey. His ram had very nice character and substance, good ribs and shoulders, and quite that Cotswold top-knot which is calculated to save many a sore head from being patched over with rag and tar. Its touch was as firm as wax, and it stood on "two pair of fore-legs." The breed has proved itself hardy, and well calculated to cross with the Welsh sheep of the district. The entries in the Mountain Breeds included six Lancashire Lonks (to whose tap-root some of the Welshmen laid claim), and only two Exmoors; but Mr. Jonathan Peel, with his celebrated "Mountain King" tribe, took everything before him. The judges thus remark on these local classes:—

"Class CVII.—X.—The Ryeland sheep shown on this occasion were a very good specimen of a breed now almost extinct, but which were formerly in great favour in Hereford. Some of the Welsh sheep bear evidence of having been transplanted to a better soil than that from which the veritable Welsh mutton is supposed to come. The winning Lonks were of great size, with heavy, strong wool, and consequently vanquished the more orthodox-looking little mountaineers opposed to them. Still we could not help thinking that over a haunch of the latter, at the proper season, the decisions might have been reversed, although in the show-yards they could not be so."

PIGS.—The principal feature of this part of the show was the great advance made by the Berkshires, whose entries increased from 39 to 51. The head prize both in the boar and sow classes was won last year by the late Sir R. G. Throckmorton; and Mr. W. Hewer and Mr. W. J. Sadler, who then took seconds in these classes respectively, stood first this year. In the Boar Class there were three "highly commended" and three "commended." The Sow Class was commended as a whole, and the third place was again awarded to the Royal Agricultural College. The first prize for the pen of three sows went to a new exhibitor, Mr. Joyce, of County Waterford, whose entries were also third, and highly commended in the boar class. Mr. Wainman showed in ten classes, and bettered his five firsts and two seconds at Battersea, with seven firsts, a second, and a third. His "Worcester Duke, late Albert," "King Cube," "The Nabob," "Lord of the Wassail," "Fresh Hope," and a pen of young sows, entitled "Advance Symmetry," "Advance Quality," and "No Surrender," were first prize winners. Mr. Crisp had four firsts for his sow and boar of the small black breed, and his small white and middle white sows. In the last-named class he beat Mr. Wainman's "Lucky Link" and "Happy Link," which were not so fortunate as "Missing Link" in 1862. Suffolk's small black boar contest again lay between Mr. Sexton and Mr. Crisp, and with the opposite result to last year. One of the Pig Judges thus writes:—

"Class LXXIV. (Boars of Large Breed) was represented by two pens only, and neither of special merit.

"Class LXXV. (Boars of Small White Breed)—a good class, and well represented by eighteen animals, and several of merit. These are a very useful and profitable sort of pig, combining quantity with quality.

"Class LXXVI. (ditto Black Breed) was good, but nothing extraordinary.

"Class LXXVII. (Berkshire Boars).—This class was very superior to anything of its kind which has been exhibited at the Royal for these three years. A very great improvement is visible this year as to numbers, symmetry, and quality, &c.

"Class LXXVIII. (Boar not eligible for preceding classes).—There was nothing to comment on.

"Class LXXIX. (Breeding Sow of Large Breed).—The first prize sow in this class was a very superior animal of her kind, and the class was good in general.

"Class LXXX. (Sow of Small White Breed)—This was an extensive one, 19 pens being shown, and the judges had great difficulty in arriving at a satisfactory conclusion, as the competition was very close; a capital class.

"Class LXXXI. (Sow of Small Black Breed).—A good class, but nothing of extraordinary merit.

"Class LXXXII. (Berkshire Sows).—The best class of its kind that I ever judged. In this class, as well as in Class 77, there is more manifest improvement than in any other breed.

"Class LXXXIII. (Sow not eligible for preceding Classes).—There were some very useful animals for general purposes in this class; but, coming as they do between the large and small breeds, I do not think that anything special can be said of them.

"Class LXXXIV. (Pen of Three Breeding Sow Pigs of Large Breed between Four and Eight Months).—There were only two pens in the competition. A third was shown, but it consisted of two sows and one boar, which could not constitute a 'pen of three breeding sows.'

"Class LXXXV. (ditto Small White Breed).—This class was represented by four pens; the first and second pens were very good.

"Class LXXXVI. (ditto Small Black Breed).—This class was not represented by anything beyond (to use the common expression) 'good and useful animals.'

"Class LXXXVII. (ditto Berkshire Breed) again bore out the character of their seniors, as mentioned in their respective classes.

"Class LXXXVIII. (ditto not eligible for Preceding Classes) was nothing extraordinary."

He then adds :—

"I cannot close my Report without alluding to the six pens of Berkshire boars exhibited in Class LXXVII. by Mr. William Joyce, of the Abbey Farm, Waterford, as being six of the best (and all from the same litter), that I ever saw of the kind; and I understand that the same exhibitor also showed a pen of three sows, sisters to the six above alluded to, and very good although not taking a prize. Take the exhibition of pigs as a whole, it was a good one; but the absence of Lord Wenlock, with his breed of Small Whites, was a drawback to it. In my Report of the last two years I have alluded to their superiority. I would also recommend a more strict observance of 'the Registration Act,' in order to avoid any mark so unpleasant in a public Show-yard as we occasionally see placed over an unfortunate pen."

XXVII.—*Report of the Judges of Steam Cultivators at Worcester.*

THE description of the Trial Fields at Worcester, and of the Steam Cultivators there set in motion, having been embodied in Mr. Clarke's Essay (see p. 365), the Report of the Judges, which follows, stands alone, though it will doubtless be read in connection with Mr. Clarke's comment.

Report of the Judges of Steam Cultivators.

THE Prizes offered by the Royal Agricultural Society for Steam-Cultivators were divided into two distinct classes, viz.: To Class I., "for the general application of Steam-power to the Cultivation of the Soil," was assigned the Gold Medal and 50*l.*; and to Class II., "for the best application of Steam-power which may be efficiently and safely adapted for *small* Occupations," 50*l.* was also appropriated.

A preliminary trial took place on Wednesday July 15th, at the Nunnery Farm, near Worcester, to afford an opportunity to the competitors for properly arranging and adjusting their respective machines and tackle. This arrangement seemed to give general satisfaction to the exhibitors, many of whom found it necessary to make various alterations in their appliances; but, beyond a superficial inspection, no official notice was taken of this trial. The soil, which was of a fair depth, with a slight admixture of gravel, lay in flat ridges; part of the land was wheat-stubble, and on the other part vetches had just been eaten off. Eight plots, of 1½ acres each, were measured off and assigned by lot. As some of these machines did not again come under our notice, we will at once offer a few words in explanation of their most prominent characteristics, reserving the description of the rest for our account of the subsequent trials.

Mr. Hayes, of Stony Stratford, employs a stationary engine and self-acting windlass; the peculiarity of his system being that the anchor-men at the headlands can instantly stop the action of the plough without stopping the engine; no signals are required, and the work may be performed in foggy weather. One man superintends the engine and windlass, and no wheels are required to be put in or out of gear, owing to the winding-drums being driven by band-wheels, and the engine-strap being shifted from one to the other as required; whilst by the simple movement of a handle the pulling-drum is instantly stopped, the rotation of the paying-out drum arrested by a steam-pressure break, and the motion of both drums reversed. With this apparatus Fowler's cultivator was set to work, which, however, did not accomplish its allotted portion, owing to an accidental fracture of the drum from some irregularity in the coil of the rope.

Messrs. Turner, of Ipswich, also exhibited a steam-cultivating apparatus, in which the chief characteristic was a chain of a novel form, invented by Mr. Collinson Hall, of Navestock. Unlike the ordinary wire-rope of Messrs. Fowler and Howard, this chain consists of a number of round steel rods, 18 inches in length, with open circular ends, which are connected by a pair of flat plates 4 inches long, riveted together through the open ends of the two bars, so as to form joints. These plates have an aperture in their centre, which enables them to fit closely round certain projections on the drum, which is polygonal instead of circular, the length of the principal faces corresponding with that of the steel rods. This is evidently an ingenious invention, though it yet remains to be proved to what extent it will withstand the immense amount of friction which must necessarily arise from a continuous drag over

finity soils in the absence of *porters*, which are not professedly a part of the system. The wear and tear falls principally upon the round rivet-heads which project. These, however, are not costly, and can be quickly repaired. The steel bars themselves, unless there be a flaw in the open circular end, would be extremely durable. The time occupied in uncoiling and riveting the chain preparatory to work, and in packing it up at the end of the task, is necessarily a considerable drawback from the professed advantages of this rope-economy.

On the following morning (July 16th) lots were again drawn, and the various machines were set to work in an adjoining field, the time occupied in the removal and setting down having been carefully noted. And now commenced the actual trials for Class II. The field operated on contained about 14 acres of a stiff loam, of which part was in second year's clover, and the rest a bean-stubble which had not been ploughed since last harvest. The land was dry, and rendered hard by the treading of sheep, a certain portion of it being laid in narrow ridges, which were difficult to work across; the rest, however, presented a fair trial for steam-cultivation, exhibiting, like the rest of the farm, marks of clean farming and high cultivation, on which we beg to congratulate the venerable tenant, Mr. Pitcher. To each competitor about 2 acres were assigned, with the direction to *cultivate* at a depth of 7 inches, equal quantities of coal being allowed. Mr. Coleman's scarifier unfortunately broke down at the commencement of the trial, but the rest finished their respective plots. The subjoined Table (I., p. 482) explains the results obtained.

Plot No. 1 was drawn by Mr. Fowler, who went to work with his 5-tined balance cultivator, drawn by his 10-horse single-cylinder engine, with clip-drum and travelling anchor, making excellent work where the ground was level, though, owing to the depth of the furrows, here and there a small space was missed. The method, now adopted differs from that pursued at Leeds with the same power (10-horse), inasmuch as there is now a rigid connection between the engine and windlass. It appears from the above Table that this engine consumed a somewhat extravagant amount of fuel, which we, in some degree, attributed to leakage in the tubes. His work was executed at about the rate of 3 miles per hour, there being no stoppage worthy of note, whilst his staff consisted of 3 men and 3 boys. The steerage, however, did not work with its usual precision, owing to a slight defect in its mechanism.

Plot No. 2 fell to the lot of Messrs. Howard, who used their 3-tined cultivator, fitted with 13-inch shares, and an ordinary 10-horse double-cylinder engine, with double compensating snatch-block. On the upper and lighter portion of the field the land was well cut, though not sufficiently *moved* from its original position; whilst on the lower and stronger part much of the ground was missed in the furrows, the implement, from its non-yielding form, being unable to adapt itself to the irregularities of ridge and furrow. Since the more extended application of steam-power to land cultivation will necessarily abolish the existence of ridge and furrow, this cannot be looked upon as a very serious imperfection in the machine. Another slight objection to it may be found in the fact that the wheels traverse the ground already cultivated, thereby to a certain extent reconsolidating it. Their staff consisted of 5 men and 2 boys.

Plot No. 3 was apportioned to Messrs. Savory and Son, who worked their *two* double-cylinder 10-horse engines, pulling Howard's cultivator to and fro between them at the rate of about 5 miles per hour,—a pace that prevented the implement settling properly to its work, whilst the engines were driven at a great speed, and with a pressure of 100 lbs. per square inch. The propriety of allowing this apparatus to compete in this class was very questionable, inasmuch as the very fact that it requires *two* engines at once places it beyond

2 1, 2 the

CLASS II.

TABLE I.—COMPETITION OF CULTIVATORS, TILLING 1A. 3B. 34P. AT A DEPTH OF 7 INCHES, JULY 16TH.

Names.	Article.	Price in £.	Working Pressure of Steam in lbs.	Nominal Horse-power.	Total Fuel consumed.	Time occupied.	Cost of Coal used, at 1s. per cwt.	Cost of Coal per Acre.	Number of Acres per Day of 10 Hours.	Cost of Labour per Day.	Wear and Tear and Interest on Capital per Day.	Total Cost per Acre.
1 John Fowler	4341	540	70	10	cwts. qrs. lbs. 3 1 2	1 57	3 3.21	1 7.98	9.56	15 1	9 5.4	4 9.05
2 Howard ..	2013	520	70	10	3 0 19	1 57½	3 2.03	1 7.38	9.08	16 2	9 1.2	4 11.38
3 Coleman ..	4307	645	65	10								
				2 engines, 10 horse-power each.	5 1 10	1 41	5 4.07	2 8.65	11.48	11 3	17 6	6 1.08
4 Savory ..	2927	1000	100	10	3 3 21	3 1	3 11.17	2 0.07	6.12	16 0	8 7.32	6 10.12
5 Smith ..	950	492	60	10								

N.B.—The interest on capital is supposed to be 5 per cent. per annum, divided among 200 working days per year. The wear and tear is taken at 12½ per cent. per annum, divided among 200 working days per year. The total cost per acre includes 1s. for oil and 4s. for water for each engine per day, but does not include the cost of removals and setting down.

CLASS II.

TABLE II.—COMPETITION OF PLOUGHS.

Names.	Working Pressure of Steam in lbs.	Total Fuel consumed.	Time occupied.	Cost of Coal used, at 1s. per cwt.	Cost of Coal per Acre.	Number of Acres per Day of 10 Hours.	Cost of Labour per Day.	Wear and Tear and Interest on Capital per Day.	Total Cost per Acre.
1 John Fowler	70	cwts. qrs. lbs. 2 3 8	1 35	2 9.85	2 8.08	7.5	15 1	10 8.27	6 8.67
2 Howard ..	70	2 2 2	1 37	2 6.21	2 0.17	7.0	16 2	9 7.2	6 4.91
3 Savory ..	100	3 2 25	1 33½	3 8.68	2 11.74	7.95	11 3	18 0	7 10.99

N.B.—When they are provided with a plough in addition to the cultivator, the cost of Fowler's tackle is increased by 47½, that of Howard and Savory by 29½.

the requirements of a "*small occupation*." A more detailed description of it will therefore be found under Class I.

Plot No. 4 fell into the hands of Mr. Smith, with his 10-horse double-cylinder engine, driving his windlass and 3-tined grubber, with 4-inch spud points, in the usual way. Throughout the whole of this trial he preserved a uniform and steady pace, making by far the best work over ridge and furrow, and stirring the soil most effectually. The only drawback seemed to be the very narrow width of land taken, and the consequent length of time (3 hrs. 1 m.) required to complete his work, whilst the manual labour—that of 6 men in attendance—seemed proportionally expensive.

At intervals during this trial portions of land in each plot were carefully cleared of all the moved soil, so as to expose to view that which remained unmoved, which, without an exception, presented to the eye a corrugated and uneven surface, in itself evidence enough of the *incompleteness* of the *single* operation of cultivating or grubbing land which has not been previously broken up; whilst the double process with a supplementary cross-cultivation is necessarily much more costly. This portion of the trial being over, such competitors as could furnish ploughing-tackle were then requested to plough a small portion (1½ acre) each, at a depth of about 6½ inches. This brought out *three* competitors, viz. Fowler, Howard, and Savory, whose performances are recorded above. (See Table II., p. 482.)

(a) Fowler, using his 4-furrow plough, made somewhat rough and uneven work, the soil apparently varying much at the different ends of the field. His staff consisted of 4 men and 3 boys, or 1 man more than he required for cultivating.

(b) Howard worked his new 3-furrow plough, the frames of which are raised and lowered in such a manner that the set of ploughs out of work is independent of, and has no tendency to weigh, or raise out of the ground, the set in action, which, of course, has the effect of steadying it in hard work. As ploughing, this implement made decidedly the best work of the three, though not quite so deep as Fowler's, inverting the soil regularly, and leaving it in a neatly-formed furrow, which was evidently due to the peculiar shape of mould-board for which the Bedford firm has been so long famous. The frame of the plough, which vibrated considerably, appeared, however, to be too light in make, and consequently liable to be strained.

(c) Savory, in connexion with his *two* engines, used a Fowler's 4-furrow plough, which was driven much too fast to make neat work, and broke a body of one plough in consequence. He was ordered to drag to the gate the whole of his tackle, with rope coiled and plough attached to the engine, as soon as he had done, which operation he performed in 3½ minutes from the time he finished his ploughing.

At this stage Mr. Fowler was ordered to move to an adjoining plot, on which to work his digging-breasts, and it was in this instance that we had presented to our notice the most successful attempt at steam-cultivation. This implement, by the action of semi-inversion, so thoroughly moved and mixed every particle of soil as really to leave little or nothing to be desired further. Indeed, this may fairly be described as the perfection of autumn cultivation on clean land. The result of this operation does not appear in the tabulated form.

The trials for Class II. were now concluded, but we must not omit to mention that we had the privilege of witnessing in actual operation Mr. Smith's combined cultivator and drill, which was *not* entered for competition. The ground was evidently too hard and rough to break up satisfactorily into a seed-bed; at the same time it is evidently a *clever implement*, and likely to suit the lighter soils of this country for spring-seeding, for which its ingenious and indefatigable inventor undoubtedly intended it.

CLASS I.

On Friday, July 17th, the competition for the Gold Medal and 50l. commenced at Wadborough, about eight miles from Worcester, on the farm of Mr. Smithin. The field selected was a clover lea, evidently in a clean and high state of cultivation, having a gentle incline to the south-west. The quality of the soil varied exceedingly: the top portion being quite of a light character, mixed with small pebbles, whilst the bottom part was an extremely tough and retentive clay, considerably baked and cracked by the action of the sun.

Lots having again been drawn, the various competitors took up their position in the prescribed order. Steevens having unfortunately broken the connecting-rod of his engine at the outset was necessarily unable to proceed in competition during the rest of the day, whilst Coleman was equally unfortunate; both, however, while in action, made satisfactory work. (See Table III., p. 485.)

Plot I. fell to Fowler's lot, who started his *digger* with 3 *breasts*, driven by a PAIR of 12-horse self-moving engines, with winding drums and coiling gear attached. The engines, placed one on each headland, work alternately, the implement being pulled backwards and forwards between them. The work accomplished by this set of tackle was truly marvellous (though on the lighter portion of the field the pace was too quick). Nearly 2 acres were finished in 2 hours 33 minutes. His staff was 3 men and 2 boys.

Plot 2 was assigned to Howard, who worked his ordinary 3-tined cultivator with his 10-horse engine,—in fact, the same tackle as in Class II. On the lighter portion of the land his depth of work was 7 inches: it was cleanly out, though not sufficiently *stirred*; in fact, a shower of rain would again have made it an *excellent pasture* in a very short time. On the lower and heavier portion of the field a depth of 9 inches was attained and well moved, though the work was a good deal overlapped, which caused it to present a satisfactory appearance to the eye; but we noticed that the cultivator did not take more than *two-thirds* of its width of *fresh ground*, which at once explains the cause of the length of time occupied and the excessive amount of fuel consumed. His staff consisted of 5 men and 2 boys.

Plot 3 was drawn by Fowler for his 14-horse engine and 5-tined cultivator. The depth attained on the light portion was about 6 inches; the soil being well mixed, but the unmoved surface as ridged and irregular as in Class II. On the stronger division the soil was splendidly moved to a depth of from 9½ to 10 inches. His staff of attendants included only 2 men and 3 boys, and it is an interesting fact that his large tackle requires fewer hands than the smaller one. On reference to Table No. 3, it will be seen that the work done on this lot was at a less cost than any of the rest, and the time occupied also shorter.

Plot 4 was allotted to Savory, who, without any assistance, quickly steamed into position, and commenced work with one of Howard's grubbers. In his system two engines are employed, one on each headland. Around the boiler of each a drum is hung on friction-rollers, which is capable of coiling upwards of 500 yards of wire rope in a single layer. A pair of small guide-rollers are ingeniously guided by the action of a screw along the front of the drum, for the purpose of regulating the coiling of the rope. The field is traversed by only one length of rope, since one engine is letting out while the other is taking up and coiling its rope, the cultivator, of course, moving to and fro accordingly. The advantages of this method seem to be, first, the size of the drum—nearly 6 feet in diameter—around which the rope is wound; secondly, the traction being direct from the cultivator to engine, and not round anchors or blocks, whereby the liability to breakage is diminished, and the wear and tear considerably reduced. We have here a minimum of rope required, as well

CLASS I.

TABLE III.—COMPETITION OF STEAM CULTIVATORS WORKING AT A DEPTH OF 7 INCHES, JULY 17TH.

Names.	Articles.	Price in £.	Working Pressure of Steam in lbs.	Nominal Horse-power.	Total Fuel Consumed.	Quantity of Land Cultivated.	Description of Work Done.	Time Occupied.	Cost of Coal used at 12. per cwt.	Cost of Coal per Acre.	Number of Acres per Day of 10 Hours.	Cost of Labour per Day.	Wear and Tear and Interest on Capital per Day.	Total Cost per Acre.
1 Fowler.	4343	1220	105	2 engines, 12 horse-power each.	5 0 0	1 3 28	Digging.	2 38	5 0	2 7-16	6-64	13 0	21 4-2	9 1-99
2 Howard.	2013	520	70	10	4 1 23	1 3 6	Cultivating.	2 54	4 5-43	2 5-59	5-59	16 2	9 1-2	7 10-96
3 Fowler.	4340	948	75	14	4 0 23	1 3 17	"	1 44	4 2-46	2 0-78	10-43	12 9	14 1-0	6 0-9
4 Savory.	2927	1000	100	2 engines, 10 horse-power each.	5 0 26	1 3 28	"	1 57	5 2-78	2 8-61	9-79	11 3	17 6	6 8-1
5 Smith.	940	492	65	10	3 0 23	1 3 16	"	2 56	2 5-53	1 3-35	5-97	16 0	8 7-38	6 2-88

CLASS I.

TABLE IV.—STEAM CULTIVATION ON HEAVY LAND, JULY 18TH.

Names.	Articles.	Price in £.	Working Pressure of Steam in lbs.	Nominal Horse-power.	Total Fuel Consumed.	Quantity of Land Cultivated.	Description of Work Done.	Depth in Inches.	Time Occupied.	Cost of Coal used at 12. per cwt.	Cost of Coal per Acre.	Number of Acres per Day of 10 Hours.	Cost of Labour per Day.	Wear and Tear and Interest on Capital per Day.	Total Cost per Acre.
1 Fowler.	4,240	948	75	14	9 0 0	1 3 6	Digging.	8	3 39	9 0	5 0-41	4-66	12 9	14 1-0	11 10-51
2 Smith.	960	492	65	10	4 2 25	1 3 7	Cultivating.	6	4 8	4 8-76	2 8-21	4-01	16 0	8 7-32	10 6-91
3 Howard.	2,013	520	70	10	6 0 0	1 3 7	"	6	5 0	6 0	3 4-13	3-35	16 2	9 1-3	12 7-91
4 Fowler.	4,242	1220	105	2 engines, 12 horse-power each.	3 0 15	0 1 27	Digging.	11 to 14	1 12	3 1-6	7 5-77	3-48	15 0	21 4-3	20 1-97

well as of friction. By this means any implement can be used, as no gearing is required, and any shaped field can be readily cultivated. The staff of hands required is 3 men and 1 boy. The work performed in this instance was done, as usual, at racing speed; but it does not appear advisable to exceed *three* miles per hour where steady and difficult work is to be done. This, like Fowler's double-engine system, seems peculiarly adapted for Continental use, and for working for hire in this country where removals from place to place are constantly made.

Plot 5 was taken by Smith, who, though taking a very narrow width, did steady, careful, and effective work. His tackle was similar in every respect to that entered in Class II. On the lighter land his depth registered 6 inches, the work being well cut and not much ridged, and on the stronger portion the depth was much the same. (See Table III., p. 485.)

On the following day Savory attached his engines to Steevens's plough, which is evidently a well-devised implement for steam-cultivation, though some of its parts were not sufficiently strong for the work on which it was engaged. It consists of two frames; the upper one fixed, and the under one divided into two portions, each being independent. The cutting parts are attached to the under frames, and are raised or lowered by means of a rack and pinion. This plough was only intended for an 8-horse engine, and was in this case consequently over-tasked. Savory also used Fowler's digger, to show the capabilities of his engines for working a variety of implements.

The concluding trials took place on Saturday, July 18th, in an adjoining field of old sward, on the heaviest and most obdurately-hardened of clays. It was, in fact, a test of the utmost power and endurance of the apparatus in most difficult and trying operations.

1. Fowler started with his 8-furrow digger and 14-horse engine, producing wonderful work by digging all the soil to a depth of from 8 to 10 inches, and tearing up immense and unwieldy blocks of unyielding earth, which were thrown several feet away. The land was left in a much rougher state than could have been desired except for autumn cultivation.

2. Smith took the next lot with his grubber, which smashed the soil up to the depth of 5 to 6 inches, but was very subject to choking, and often, during the early part of the work, did not overlap sufficiently, but left a strip of unmoved ground between each bout. It had the advantage, however, of getting into the furrows in a most satisfactory manner.

3. Howard followed in his turn; but did not make the work that could have been desired, passing over a large portion of work already done by overlap, and in many places not moving the soil sufficiently from its original position.

4. Fowler completed the quartett with his digger, drawn backwards and forwards by his double-engine system, making good work to the depth of 11 to 14 inches; but, before proceeding far, he unfortunately broke his winding-drum. (See Table IV., p. 485.)

In conclusion, we would remark that there does not seem to be any marked improvement in the steam cultivators exhibited at Worcester over those exhibited at Leeds in 1861. The apparatus of Messrs. Fowler and Howard, with the exception of some increase in simplicity, appear identically the same as then. Mr. Smith's cultivator, however, was not tried at Leeds, and was, therefore, a comparative novelty in competition, though it is extensively employed throughout the country. The systems of Messrs. Steevens and Coleman yet require further development, whilst the implements themselves need strengthening in some of their parts, so as to adapt them for general use: whilst despite of "the economical application of steam-power to the cultivation of the soil," in the case of Messrs. Savory's system there is great room for improvement in the manufacture and finish of their engines. Steam-power has now been

fairly launched as part of the system of the agriculture of this country, and that it can be economically and satisfactorily applied in the thorough cultivation of our soil must be fairly established to the satisfaction of the most fastidious by a reference to the above Tables.

We cannot conclude this Report without tendering our thanks to the Stewards of our Department for their unfailing kindness and courtesy, as well as for the prompt manner in which all our directions were carried out. We would also remark, that the short time allowed for the preparation of this Report has led to its being brought out in a hurried manner; and thus we have been prevented from embodying in it much that otherwise we could have wished to make public. Lastly, we would suggest, for the benefit and consideration of the Council, that a much more *lengthened* and *extensive* trial of steam-cultivators should in future be instituted, on which such conclusions may be based as may be of service to the public.

Our Awards were as follow :—

STEAM CULTIVATORS.—Class 1.

Gold Medal and 80*l.* to John Fowler for his 14-horse Set of Steam Ploughing Machines, complete.—1st Prize.

20*l.* to William Savory and Son for their two 10-horse Self-propelling Winding Engines.—2nd Prize.

Silver Medal to William Steevens for his 4-furrow Steam Plough and Cultivator combined.—3rd Prize.

Commended, Coleman and Sons' set of Steam Cultivating Apparatus.

STEAM CULTIVATORS FOR SMALL OCCUPATIONS.—Class 2.

25*l.* to John Fowler for his 10-horse Set of Steam Ploughing Machinery, complete.—1st Prize.

15*l.* to William Smith for his 10-horse Set of Steam Ploughing Machinery, complete.—2nd Prize.

10*l.* to J. and F. Howard for their 10-horse Set of Steam Ploughing Machinery, complete.—3rd Prize.

WM. OWEN, Engineer.

H. B. CALDWELL.

CLARE SEWELL READ.

JACOB WILSON.

XXVIII.—*Report on the Worcester Show-yard.*

THANKS to the unwearied efforts of the local and central authorities, the Worcester Meeting has been brought to a generally successful issue, although, while it was in progress, variations of temperature and weather as wide as often characterize an English summer, checked the influx of visitors, and threatened more serious interruption. The relation of this Meeting to its predecessors is clearly exhibited in the following tabular statement, drawn up for the Stewards by Mr. Wainwright.

STATEMENT of RECEIPTS and ADMISSIONS of the COUNTRY MEETINGS of
the ROYAL AGRICULTURAL SOCIETY of ENGLAND, from 1852 to 1863
inclusive.

LEWES, 1852.

Prices of Admission.	Days of Admission.	Persons.	Amount Received.	Received for Catalogues.
Implement Yard, 2s. 6d.	Wednesday, July 14	835	£. s. d. 104 7 6	£. s. d.
Cattle Yard, 5s.	Wednesday, ,, 14	431	107 15 0	
Implement and Cattle Yards, 2s. 6d.	Thursday, ,, 15	}	972 7 10	
Implement and Cattle Yards, 1s.	Friday, ,, 16			
			1184 10 4	170 19 0

TOTAL : Number of Persons,

Amount received for Admissions, 1184*l.* 10*s.* 4*d.*

GLOUCESTER, 1853.

Prices of Admission.	Days of Admission.	Persons.	Amount Received.	Received for Catalogues.
Implement Yard, 2s. 6d.	Wednesday, July 13	2,571	£. s. d. 321 7 0	£. s. d.
Implement and Cattle Yards, 2s. 6d.	Thursday, ,, 14	9,720	1214 19 7	
Implement and Cattle Yards, 1s.	Friday, ,, 15	23,915	1195 15 4	
Implement and Cattle Yards, 1s.	Saturday, ,, 16	39	1 19 0	
		36,245	2734 0 11	377 7 6

TOTAL : Number of Persons, 36,245.

Amount received for Admissions, 2734*l.* 0*s.* 11*d.*

LINCOLN, 1854.

Prices of Admission.	Days of Admission.	Persons.	Amount Received.	Received for Catalogues.
Trial Yard, 10s.	Thursday, July 13	9	£. s. d. 4 10 0	£. s. d.
	Friday, ,, 14	11	5 10 0	
	Saturday, ,, 15	20	10 0 0	
	Monday, ,, 17	20	10 0 0	
	Tuesday, ,, 18	21	10 10 0	
Implement Yard, 2s. 6d.	Wednesday, ,, 19	2,201	278 8 2	
Cattle Yard, 10s.	Wednesday, ,, 19	752	376 0 0	
Implement and Cattle Yards, 2s. 6d.	Thursday, ,, 20	12,501	1566 4 8	
Implement and Cattle Yards, 1s.	Friday, ,, 21	22,100	1109 16 7	
		37,635	3370 19 5	420 0 6

TOTAL : Number of Persons, 37,635.

Amount received for Admissions, 3370*l.* 19*s.* 5*d.*

CARLISLE, 1855.

Prices of Admission.	Days of Admission.	Persons.	Amount Received.	Received for Catalogues.		
			£. s. d.	£. s. d.		
Trial Yard, 5s.	Thursday, July 19	}	88 15 0			
	Friday, ,, 20					
	Saturday, ,, 21					
	Monday, ,, 23					
	Tuesday, ,, 24					
Implement Yard, 2s. 6d.	Wednesday, ,, 25	}	2190 5 10			
Cattle Yard, 10s. ..	Wednesday, ,, 25					
Implement and Cattle	Thursday, ,, 26					
Yards, 2s. 6d.	Friday, ,, 27					
Implement and Cattle	982 18 8					
Yards, 1s.			3261 19 6	425 6 1		

TOTAL: Number of Persons,
Amount received for Admissions, 3261*l.* 19*s.* 6*d.*

CHELMSFORD, 1858.

Prices of Admission.	Days of Admission.	Persons.	Amount Received.	Received for Catalogues.
			£. s. d.	£. s. d.
Implement Yard, 2s. 6d.	Tuesday, July 15	947	117 13 6	
Implement Yard, 2s. 6d.	Wednesday, ,, 16	2,357	294 10 0	
Cattle Yard, 5s.	Wednesday, ,, 16	1,215	303 15 0	
Implement and Cattle Yards, 2s. 6d.	Thursday, ,, 17	28,463	2272 9 11	
Implement and Cattle Yards, 1s.	Friday, ,, 18			
		32,982	2988 8 5	334 13 0

TOTAL: Number of Persons, 32,982.
Amount received for Admissions, 2988*l.* 8*s.* 5*d.*

SALISBURY, 1857.

Prices of Admission.	Days of Admission.	Persons.	Amount Received.	Received for Catalogues.
			£. s. d.	£. s. d.
Implement Yard, 2s. 6d.	Tuesday, July 21	989	121 5 6	
Implement Yard, 2s. 6d.	Wednesday, ,, 22	2,623	327 6 2	
Cattle Yard, 5s.	Wednesday, ,, 22	1,319	329 18 2	
Implement and Cattle Yards, 2s. 6d.	Thursday, ,, 23	14,004	1748 7 3	
Implement and Cattle Yards, 1s.	Friday, ,, 24	18,427	920 18 8	
		37,342	3447 15 9	
				324 17 0

TOTAL: Number of Persons, 37,342.
Amount received for Admissions, 3447*l.* 15*s.* 9*d.*

CHESTER, 1858.

Prices of Admission.	Days of Admission.	Persons.	Amount Received.	Received for Catalogues.
			£. s. d.	£. s. d.
Trial Yard, 5s.	Thursday, July 15	53	13 5 0	..
	Friday, ,, 16	144	36 0 0	..
	Saturday, ,, 17	270	31 10 0	..
	Monday, ,, 19	238	59 9 8	..
Implement Yard, 2s. 6d.	Tuesday, ,, 20	1,251	156 5 6	36 13 0
Implement Yard, 2s. 6d.	Wednesday, ,, 21	4,887	610 9 10	152 12 0
Cattle Yard, 5s.	Wednesday, ,, 21	3,180	794 16 0	
Implement and Cattle Yards, 2s. 6d.	Thursday, ,, 22	24,790	3101 3 6	262 1 6
Implement and Cattle Yards, 1s.	Friday, ,, 23	27,726	1387 4 6	71 6 8
		62,539	6190 4 0	522 13 2

TOTAL: Number of Persons, 62,539.

Amount received for Admissions, 6190*l.* 4*s.* 0*d.***WARWICK, 1859.**

Prices of Admission.	Days of Admission.	Persons.	Amount Received.	Received for Catalogues.
			£. s. d.	£. s. d.
Implement Yard, 2s. 6d.	Tuesday, July 12	1,689	210 17 6	36 1 0
Implement Yard, 2s. 6d.	Wednesday, ,, 13	5,154	644 4 2	144 12 0
Cattle Yard, 5s.	Wednesday, ,, 13	3,386	844 18 6	..
Implement and Cattle Yards, 2s. 6d.	Thursday, ,, 14	19,902	2487 17 6	274 8 0
Implement and Cattle Yards, 1s.	Friday, ,, 15	25,446	1274 0 3	49 5 2
		55,577	5461 17 11	504 6 2

TOTAL: Number of Persons, 55,577.

Amount received for Admissions, 5461*l.* 17*s.* 11*d.***CANTERBURY, 1860.**

Prices of Admission.	Days of Admission.	Persons.	Amount Received.	Received for Catalogues.
			£. s. d.	£. s. d.
Trial Yard, 5s.	Wednesday, July 4	19	4 15 0	..
	Thursday, ,, 5	52	13 0 0	..
	Friday, ,, 6	49	12 5 6	..
	Saturday, ,, 7	41	10 5 0	..
Implement Yard, 2s. 6d.	Monday, ,, 9	813	101 13 0	56 1 0
Cattle Yard, 5s.	Monday, ,, 9	459	114 15 0	..
Implement and Cattle Yards, 2s. 6d.	Tuesday, ,, 10	5,866	732 18 3	115 13 0
Implement and Cattle Yards, 1s.	Wednesday, ,, 11	20,881	1043 10 3	70 4 0
Implement and Cattle Yards, 1s.	Thursday, ,, 12	14,124	706 5 10	31 14 0
		42,304	2739 7 10	273 12 0

TOTAL: Number of Persons, 42,304.

Amount received for Admissions, 2739*l.* 7*s.* 10*d.*

LEEDS, 1861.

Prices of Admission.	Days of Admission.	Persons.	Amount Received.	Received for Catalogues.
Implement and Cattle Yards, 5s.	Monday, July 15	2,027	£. s. d. 505 19 0	£. s. d. 116 5 0
Implement and Cattle Yards, 2s. 6d.	Tuesday, ,, 16	10,287	1285 8 4	235 1 0
Implement and Cattle Yards, 2s. 6d.	Wednesday, ,, 17	18,823	2351 4 2	229 4 0
Implement and Cattle Yards, 1s.	Thursday, ,, 18	73,824	3695 9 3	81 9 0
Implement and Cattle Yards, 1s.	Friday, ,, 19	40,777	2051 15 5	18 19 0
		145,738	9889 16 2	680 18 0

TOTAL: Number of Persons, 145,738.
Amount received for Admissions, 9889*l.* 16*s.* 2*d.*

BATTERSEA, 1863.

Prices of Admission.	Days of Admission.	Persons.	Amount Received.	Received for Catalogues.
Implement Yard, 2s. 6d.	Monday, June 23	363	£. s. d. 46 0 0	£. s. d. 20 1 0
Implement Yard, 2s. 6d.	Tuesday, ,, 24	806	102 5 2	20 2 0
Implement Yard, 2s. 6d.	Wednesday, ,, 25	1,146	697 15 5	148 18 0
Cattle Yard, 1 <i>s.</i> 6 <i>d.</i> ..	Thursday, ,, 26	5,873	1467 1 7	178 7 0
Implement and Cattle Yards, 5s.	Friday, ,, 27	10,056	1261 0 3	182 0 0
Implement and Cattle Yards, 2s. 6d.	Saturday, ,, 28	8,644	1082 4 2	120 1 0
Implement and Cattle Yards, 2s. 6d.	Monday, ,, 30	28,092	1404 15 6	175 9 0
Implement and Cattle Yards, 1s.	Tuesday, July 1	38,131	1911 6 8	192 8 0
Implement and Cattle Yards, 1s.	Wednesday, ,, 2	31,217	1566 15 7	87 2 3
		124,328	9539 4 4	1124 8 3

TOTAL: Number of Persons, 124,328.
Amount received for Admissions, 9539*l.* 4*s.* 4*d.*

WORCESTER, 1863.

Prices of Admission.	Days of Admission.	Persons.	Amount Received.	Received for Catalogues.
			£. s. d.	£. s. d.
Trial Yard, 6s.	Wednesday, July 15	63	15 15 0	.. ..
	Thursday, ,, 16	97	24 5 0	.. ..
	Friday, ,, 17	60	15 0 0	.. ..
	Saturday, ,, 18	49	12 5 0	.. ..
Implement and Cattle Yards, 10s.	Monday, ,, 20	811	404 19 6	96 9 0
Implement and Cattle Yards, 2s. 6d.	Tuesday, ,, 21	7,683	960 12 1	162 12 0
Implement and Cattle Yards, 2s. 6d.	Wednesday, ,, 22	9,293	1162 2 0	104 7 0
Implement and Cattle Yards, 1s.	Thursday, ,, 23	38,282	1915 18 5	107 7 0
Implement and Cattle Yards, 1s.	Friday, ,, 24	19,469	974 13 9	28 13 0
		75,807	5485 10 9	499 8 0.

TOTAL: Number of Persons, 75,807.

Amount received for Admissions, 5485*l.* 10*s.* 9*d.*

CHARLES WALNWRIGHT, Superintendent of Admissions.

4th August, 1863.

It thus appears that there was a larger gathering at Worcester than on most former occasions.

The district, indeed, was in many respects happily chosen, being sufficiently rural, and removed from the chief centres of English life and bustle, for its inhabitants to enter with zest into this agricultural festival, sufficiently connected with the great arteries of commerce to afford the necessary facilities for locomotion, and not inexperienced in the conveyance of holiday folk to places of amusement. On the other hand, we must remark that this lesson had been but imperfectly learned, and that, either from defect of "rolling stock" or of organization, long intervals and delays occurred in the despatch of trains, during which throngs of passengers were allowed to accumulate, which, from the inadequacy of the railway staff, soon seethed into a mob.

This remark is made not as a reproach, but as a hint, that, in fixing the site of meetings dependent for success upon a large influx of visitors, not only the existence of railroads should be ascertained, but the extent of their experience and connexions.

With respect to the Show-yard, the site, a sloping airy down, was at a convenient distance from the city, and afforded a prospect of the Malvern Hills, which are so striking a feature in our western scenery. Grumblers were hard pressed to find a defect, when they complained that the area was too spacious. Their

criticism would have been more telling if pointed at the want of a good hard road of approach, which, however, it is a physical impossibility to extemporize. The display of Agricultural Machinery was as extensive as usual; and if there be good reason for subdividing it into classes for the purpose of judicial trials, there is also good ground for not attempting to describe this complex whole in a general report, somewhat hastily drawn up. Illustrations are, indeed, almost indispensable for the explanation of the action of implements; and it would cost the reader as much pains to master any verbal statement as the writer to frame it—that is to say, more than will be taken, except upon compulsion: any detailed description of machinery will therefore be best reserved for a special illustrated notice.

Again, a very slight survey, with an experienced guide, will satisfy the inquirer that exhibitions of implements, apart from trials, would be of doubtful service to the agricultural community; ingenious adjustments may be seen and appreciated *as such*, but the question arises, Will they work? The doubt is best illustrated by the following incident:—Pains were taken to give a slight trial to one of the most promising novelties at the Worcester Show: the assistance of an engine was required, but to ask the aid of the rival makers was a delicate matter. As soon, however, as a turn or two had been given to the implement in question, volunteer offers of assistance were showered down on all sides,—it being clear that the new device was at least not in fit trim for displaying superior work. Generally speaking, therefore, novelties in each class had better await their ordeal in due season, when both the pushing and the scrupulous exhibitor will find their natural level. It is therefore expedient in the main to confine the few remarks for which we have space to that class of machinery which was this year under trial, viz., the implements used in preparing corn for market.

The Judges of steam-engines report as follows:—

To the Stewards of Implements of the Royal Agricultural Society of England.

GENTLEMEN,

July 20th, 1863,

We have the honour to report to you the result of the Examination and Trials made by us of Fixed and Portable Steam-engines at the Meeting of the Society now being held at Worcester.

The following Tables apply to these Trials (see p. 494):—

Portable Steam-Engines above 8 Horse-power.—Table No. 1.

In this Class we have awarded a portion of the money placed at our disposal by the Society to four of the engines tried, in the proportions shown.

We have given a rather larger sum to Messrs. Hornsby and Sons, because their engine attained the greatest economy of fuel, and without the use of any appliances for reducing the area of fire-grate surface. The firebox of this

engine was without "lagging" on either front or sides, in the condition in which it is ordinarily sold.

PORTABLE STEAM ENGINES.

TABLE No. 1.

Name of Exhibitor.	No. of Article.	Horse-power of Engine.	Getting up Steam.					Price of Engine.	Remarks.
			Time taken in getting up Steam.	Fuel Burnt in getting up Steam.		Coal Burnt per hour.	Coal Burnt per Horse-power per hour.		
				Coal.	Wood.				
			Minutes	lbs.	lbs.	lbs.	lbs.	£.	
Hornsby and Sons . . .	1946	12	48	62.0	12	45.5	3.79	225	Prize of 100.
Clayton and Co. . . .	142	12	99	47.0	12	46.3	3.86	343	„ 7 1/2
Tuxford and Sons . . .	5004	12	69	60.5	12	55.2	4.80	355	„ 4 1/2
Barrett, Exall, and Co. .	2539	12	123	67.0	12	58.8	4.66	310	„ 4 1/2
Brown and May . . .	5774	10	78	47.3	10	54.5	5.45	265	Commended.

TABLE No. 2.

Tuxford and Sons . . .	5008	8	81	32.5	8	28.7	3.59	230	Price of 91.
Barrett, Exall, and Co. .	2538	8	99	50.2	8	30.3	3.79	238	.. 74
Clayton and Co. . . .	143	8	100	38.3	8	32.4	4.05	238	.. 74
Holmes and Sons . . .	1824	8	41	39.0	8	46.5	5.81	240	.. 44
Haywood, Junr. . . .	349	8	76	41.0	8	44.1	5.51	240	Commended.

TABLE No. 3.

Ellis and Sons	4053	7	76	40.5	7	37.5	8.21	220	{ Commended as a good serviceable engine.
Parsons	5246	8	63	34.0	8	70.6	8.82	225	
Warren (Ruston & Co.).	3663	8	95	41.5	8	75.6	9.45	230	
Gibbons	519	7	49	30.3	7	76.8	10.52	215	
Robey and Co.	4827	8	47	39.5	8	95.7	11.96	230	{ Commended as a good serviceable engine.
Childs (Riches & Watts)	5779	8	69	44.0	8	98.0	12.00	200	
Ashby and Co.	5176	4+	73	36.5	4+	67.0	12.66	138	
Gilbert	1533	5	95	31.5	5	66.4	13.28	160	
Brown and May	5776	8	85	34.0	8	81.2	6.40	220	Highly commended.

The quality of the work and finish of all these four engines were extremely good.

We commend the engine of Messrs. Brown and May, because it attained a fair amount of economy without the advantage of so much skill in the stoking as the others enjoyed.

Portable Steam-Engines not exceeding 8 Horse-power.

We have thought it desirable, in our consideration of this Class, to separate the engines into two divisions, which may be best described as including—

1st. Those engines worked on the expansive principle, which, by the use of heaters and other special arrangements, appear to aim more particularly at low consumption of fuel.

2nd. Those engines, without these arrangements, which appear in our judgment to represent the average description of engine generally purchased by farmers, and in use throughout the country.

We have distributed the amount placed at our disposal amongst the engines of Messrs. Tuxford and Sons, Barrett and Co., Clayton and Co., and Holmes and Sons, as shown on Table No. 2, in the proportions which, taking all points into consideration, they, in our opinion, respectively merit.

We commend the engine of Mr. Haywood, Junr., of Derby.

The quality of work and finish of all these engines are very high.

In the second division of this Class we commend Messrs. Ellis and Sons and Parsons for good and serviceable engines, showing a fair result as to consumption of fuel. See Table No. 3.

We have highly commended Messrs. Brown and May's engine for its performance and general construction, as being a fair representative of those most in use. It was discovered after the trial that, the fire-tubes being 2½ inches outside instead of inside diameter, this engine did not conform to the conditions of the Society at this Meeting, and was not entitled to any of the money devoted to the Class. We regret this circumstance, because the performance was highly satisfactory; especially when it is considered that the engine was, with others, selected by the Judges for trial without consulting the exhibitors, and was left for trial after an objection was raised by the exhibitors of other engines to their being tried.

The Table below refers to the Fixed Steam-engines.

FIXED STEAM ENGINES.

TABLE No. 4.

Name of Exhibitor.	No. of Article.	Horse-power of Engine.	Coal Burnt per Hour.	Coal Burnt per Horse-power per Hour.	Price.	Remarks.
Barrett, Exall, and Co. . .	2537	10	lbs. 48·8	lbs. 4·88	230	Prize of 15 <i>l</i> .
Clayton and Co.	141	10	50·4	5·04	210	„ 15 <i>l</i> .
Hornsby and Sons . . .	1945	10	55·1	5·51	215	„ 10 <i>l</i> .
Ferrabee	3373	10	71·0	7·10	230	{ Commended as a plain serviceable engine .
Tuxford and Sons . . .	5014	8	56·5	7·06	200	
Haywood, Junr.	548	10	87·7	8·77	240	
Johnson and Whittaker .	2967	4	61·3	15·32	85	

The engine shown by Messrs. Hornsby and Sons was a very good one, equal in workmanship to those of Messrs. Clayton and Co., and Barrett and Co., but it consumed rather more fuel.

We commend Mr. Ferrabee for a plain, serviceable engine, which attained good results, without the application of the expansive use of the steam.

There was but one boiler exhibited, and we have not awarded any prize for boilers.

We observe that Traction Engines, useful for agricultural purposes, are now beginning to take an important position; and we recommend that the Class be recognised by the Society by the offering of a sum of money for competition, either at the next Show or at some convenient previous date.

We have the honour to be, Gentlemen,

Your most obedient servants,

JOHN J. GOOCH,

D. K. CLARK.

The high results to which the Judges' Report testifies are produced by extreme care in manufacturing detail; friction is reduced to a minimum; heat is economized by carefully clothing the heated surfaces, and the demand for steam is diminished by cutting off the supply before the stroke is completed, or, as it is termed, "working expansively." The power so obtained involves no

necessary want of durability in the engine, because the rules prescribed by the Society sufficiently regulate the size both of the boiler-tubes and of the spaces between them: in fact success in the race depends on superior finish, rather than refinements in construction which would be of questionable service. The purchaser, then, of any one of the competing engines might well be congratulated on his acquisition, and the question would rather arise whether engines so got up can be supplied in sufficient numbers at the prices affixed. If there be any doubt on this point, the farmer may content himself with a "good serviceable engine," such as, no doubt, any of the leading makers would furnish in the regular course of business.

With respect to the consumption of fuel, some may think that it matters very little whether one or two cwts. more or less of coal be consumed in a day, and may be under the impression that the grosser feeder may probably be the more simple and durable machine: but it will generally be found that the engine which requires most fuel, also requires most repair to its boiler and tubes; indeed it is but natural to expect that ill-regulated heat should be a destructive agent.

With respect to thrashing-machines, it should not be forgotten that at Canterbury those alone were under trial which do not profess to finish the sample for market, whilst this year none but finishing machines were tested; the inference, nevertheless, should not be drawn that the simpler machine is considered to be superseded, for in the judgment of many practical men it deserves the preference, and perhaps on some future occasion we may see both classes put upon their trial at the same Meeting.

All points connected with thrashing no doubt came under the notice of the Judges in that department, and it is to be regretted that they did not record more fully the mass of information to the acquisition of which they applied themselves with unwearied assiduity.

*Report of the Judges of Portable Thrashing-Machines and Fixed
Barn-Works.*

PORTABLE THRASHING-MACHINES.

The number of entries being considerable, we judged it expedient to select only one machine from each exhibitor for trial, except in cases where two machines essentially differing in principle were exhibited. As we proceeded with the trials the policy of this step became evident, where the performance of some of these machines became in every way superior to others constructed by the same makers or exhibitors.

We commenced by according a preliminary trial to each of the machines selected, by setting them to thrash 100 sheaves of wheat, satisfying ourselves at the same time that they were equally capable of producing a good sample of barley. The results of this trial are given in the following Table:—

TABLE I.—COMBINED FINISHING THRASHING-MACHINES.

Name of Exhibitor.	Number in Catalogue.	Time in which each Machine Thrashed 100 Sheaves of Wheat.	Average Horse-power required by each Machine.	Horse-power that would be required to thrash 100 Sheaves in 1 Minute.
		Min. Sec.		
Goucher	3982	6 55	10·11	61·95
Bruckshaw	5798	4 59	6·56	32·82
Burrow	1524	4 30	7·76	34·94
Barrett and Co.	2540	5 25	6·44	34·92
Tuxford	5016	3 55	8·85	34·68
Turner	1043	5 55	4·52	26·746
Clayton and Co.	153	5 25	6·94	37·623
Wallis and Co.	1071	3 50	8·52	32·651
Barrows	204	4 25	6·03	26·65
Hornsby	1955	4 25	6·88	30·38
"	1956	4 0	7·73	30·95
Clayton and Co.	144	3 55	5·71	22·37
"	"	4 10	6·0	25·02
Marshall	5765	3 10	9·79	31·0
Nalder	540	4 0	6·95	27·83
Gilbert	1551	5 5	7·7	39·16
Gibbons	520	5 55	6·83	38·17
Underhill	5085	Machine choked twice.	Experiment discontinued.	
"	5694	4 8	8·9	36·78
Parsons	5247	4 30	8·05	36·25
Tasker	3057	3 25	11·28	38·547
Humphries	1007	4 40	8·18	38·175
Robey	4826	5 55	8·87	52·488
Savory	1277	4 5	8·79	35·88
Holmes	1822	6 3	8·03	52·22

TABLE II.—COMBINED FINISHING THRASHING-MACHINES.

Selected and Frictional Trials.

Name of Exhibitor.	Number in Catalogue.	Time in which each Machine thrashed 500 Sheaves of Wheat.	Average Horse-power required by each Machine.	Horse-power that would be required to thrash 500 Sheaves in 1 Minute.	Horse-power required to drive each Machine empty.	Prizes.
		Min. Sec.				£.
Tasker	3057	23 30	9·99	234·34	5·778	..
Wallis and Co.	1071	15 50	9·6	152·66	5·535	10
Holmes	1829	22 0	10·235	225·187	6·817	{ Silver Medal.
Robey	4826	18 35	8·7	161·797	6·1542	..
Clayton and Co.	144	22 10	7·78	172·35	3·911	15
Hornsby	1955	17 36	9·66	170·05	4·8	25
Barrett and Co.	2540	20 55	8·49	177·44	4·089	..

N.B.—Each machine was run empty for 5 minutes, and the result recorded a per last column.

The preliminary trial enabled us to select seven of the best performing machines, with 500 sheaves of wheat, for a longer test; several of the others, although commendable in many respects, not being sufficiently effective to justify us in giving them a prolonged trial.

The results obtained from the seven machines so selected are given in Table II. (p. 497), and the division of the money marks the degree of merit we attach to each machine.

In the machine, Article No. 1829, exhibited by Holmes and Son, of Norwich, we noticed a contrivance for "bagging" the chaff in a simple and effective manner. We consider the invention to be a novelty, and of essential service to the farmer, more particularly when thrashing out of doors. We bring it before your notice, and recommend that a Silver Medal be given to them for their invention.

FIXED BARN-WORKS.

In this class only four machines were exhibited; these were tried, and the essay enabled us to select two of them, which satisfied us as doing best. These two machines were again tried, when that exhibited by Hornsby and Sons did its work in such an excellent manner in every respect as entitled it to the whole of the money devoted to this Class. The power required to drive the machines is given in Table III.

TABLE III.—FIXED BARN-WORKS.

Name of Exhibitor.	Number in Catalogue.	Time in which each Machine thrashed 250 Sheaves.	Average Horse-power required by each Machine.	Horse-power that would be required to thrash 100 Sheaves per Minute.	Horse-power required to drive each Machine empty.	Prizes.
		Min. Sec.				£.
Humphries	1008	16 40	5.59	93.29	..	..
Clayton and Co. . .	145	12 55	5.83	75.39	..	..
Hornsby	1958	9 30	8.34	79.26	..	..
Barrett	2541	10 35	8.53	99.3	..	..

Renewed Trial.

		Time with 500 Sheaves.				
		Min. Sec.				
Hornsby	1958	16 5	9.25	148.837	3.58	20
Clayton and Co. .	145	Strap having come off, trial was discontinued.				
					3.93	..

N.B.—The machines were run empty during a period of 5 minutes.

In these Tables 1 horse-power is taken as being equal to 33,000 lbs. lifted 1 foot high per minute.

As several machines approached each other in excellence very closely, we considered it advisable to apply a further test to them by running each empty for five minutes, that we might the better judge whether any essential difference in the power required to drive them arose from variations in construction; and the power required under this test is shown in one column of the Tables.

We have to thank the Society for the kind assistance rendered by its

Stewards and officers. To Mr. James Amos our best thanks are also due for his indefatigable exertions and the services he rendered in ascertaining the power required, and recording dynamometrical results, besides the general assistance he gave us during the trials.

WM. CHALCRAFT, Bramshill House, Liphook, Hants. ,
JOHN HICKEN, Bourton, Rugby.
GILSON MARTIN, Thorney, near Peterborough.

Worcester, July 21st, 1863.

Among the recognised, if not the essential, adjuncts of the thrashing-machine, whether it be employed in the field or in the barn, is the Straw-elevator, of which several new and cheaper forms were exhibited at Battersea, but of course without authorized trial; the Worcester Show was therefore a fitting occasion for the Society to take such cognisance of this machine as circumstances warrant.

Those first in use are attended with this drawback—that, having a tall frame mounted on a separate four-wheeled carriage, they were not easy of transport or of stowage. Moreover, their cost—from 50*l.* to 60*l.*—was disproportionate to the requirements of the case, or even to the materials actually employed.

The endeavours of Messrs. Wright and Campaign to diminish the cost and simplify the apparatus, are deserving of special notice and trial. Wright of Boston's Stalking-machine, when self-contained, as he sends it out, packs up into a very compact form, and, when modified according to Messrs. Ransome's patent, is but an appendage to the thrashing-machine when travelling. A long net, strained and raised by shears composed either of telescopic iron tubes or of wooden poles, which slide out to a length of 30 feet, supersedes the cumbrous wooden frame which is so commonly seen standing exposed to the summer sun.

Campaign's Elevator, as exhibited by Messrs. Clayton and Shuttleworth, is preferable where the straw has to be delivered at a considerable distance and height; but this very ingenious arrangement requires the labour of one man, with probably a boy in attendance, to tie up the straw in bundles.

In the internal fittings of the thrashing-machine the most important novelty is the Corn-elevator, invented by J. W. Bruckshaw and exhibited by W. S. Underhill. This apparatus was first brought out at Battersea, but it has never until this year come under the notice of Judges, whose opinion of its merits would have been the more acceptable, since some of our first implement-makers have adopted its use.

Its action may be thus briefly explained:—The Elevator consists of an ordinary fan-spindle with blades upon it, which is driven at considerable speed. The corn from the riddles falls

into the cave containing these fan-blades, which, like a series of cricket-bats, strike the grain so as to raise it to the required height. These smart blows also separate the chaff from the corn in the "white heads" or "coshes," and carry it clear away. It professes to act also as a barley-horner, but whether a blow is as effectual as a cut for performing this operation is a point to be established only by trial.

Report of the Judges for Winnowing Machines, Corn Screens, Corn and Seed Separators, Barley Hummellers, and Miscellaneous Articles.

WINNOWING MACHINES.

The machines exhibited in this Class were numerous, and after two preliminary trials, seven were selected for further trial; and the quality of work done was the chief consideration.

Name of Exhibitor.	Article.	Quantity of Corn Winnowed.	Time.		Price.	
			Min.	Sec.	£.	s.
Smith	948	Bushels. 2	1	0	9	9
R. Hornsby and Sons	1951	..	1	25	8	0
Sawney	2731	..	1	12	11	10
Trustees of W. Crosskill	3481	..	0	43	8	10
Boby	4126	..	1	0	15	0
Cooch	1544	..	0	52	14	10
Baker	244	..	1	45	9	10

The Prize of 15*l.* was awarded to Mr. Cooch.

The Prize of 10*l.* was awarded to Mr. Sawney.

The Prize of 5*l.* was awarded to R. Hornsby and Sons.

CORN SCREENS.

Three only of these machines were tried, 2 bushels of wheat and 1 of barley being given to each. Both the quality of the work done and the time occupied were taken into account in the decision.

Name of Exhibitor.	Article.	Time.		Price.		Remarks.
		Min.	Sec.	£.	s.	
Nalder and Nalder	534	1	45	Wheat	8 0	An expanding screen, well adapted for any description of corn.
.. .. .	..	2	3	Barley	
Boby	4121	1	53	Wheat	9 8	
.. .. .	..	1	50	Barley	
Penny and Co. ..	5255	2	5	Wheat	14 14	
..	1	8	Barley		

The Prize of 6*l.* was awarded to Penny and Co.

The Prize of 4*l.* was awarded to Mr. Boby.

The corn and seed separators being nearly the same kind of implements as the above, the Prize was withheld.

BARLEY HUMMELLERS.

In this Class seven machines were tested, and the following awards made :—

To Messrs. Barrett, Exall, and Andrews, the Prize of 3*l*.

To Mr. Boby, the Prize of 2*l*.

MISCELLANEOUS ARTICLES.

Silver Medals were awarded as follows :—

Name of Exhibitor.	Article.	
R. Hornsby and Sons ..	1963	Root pulper.
Aimes and Barford	4065	Wrought-iron ballasting roller.
H. Machinder	1584	Potato separator.
E. Humphries	1013	Portable clover thrashing-machine.

COMMENDED.

Name of Exhibitor.	Article.	
Wallis, Haslam, and Steevens	1104	Patent steerage attached to drill.
Clark and Son	4059	Adjustable scythe.
A. W. Gower and Son ..	4416	Combined corn distributor.
W. S. Underhill	5126	Cheese press.
Seaman and Dipping ..	4029	Excelsior steel whippletrees.

(Signed)

G. M. HIFWELL.
ARTHUR RIGG.

With respect to the machines for dressing corn it may be remarked that, whilst the Penney's Prize Corn-screen was a new and ingenious device, Cooch's Prize Hand-dressing Machine was still pretty much in the same form as when it superseded the primitive fan fifty years ago.

Penney's Prize Expanding Corn-separator has been a good deal taken up by the makers of thrashing-machines, which is an indication that they have faith in this ingenious novelty, and the more so because any little accidental derangement is of more importance when it takes place in a combination of complicated machinery than when the machine is working by itself.

This Corn-screen is composed of a continuous coil of elastic wire, wound round the iron bars, of a skeleton drum. Near the upper end of the screen these bars are inserted, like a telescope, into hollow tubes, and are, therefore, capable of elongation, whereby the distance between each wire of the coil (in all but the head of the screen) can be increased. The screen can therefore be made coarser or finer at pleasure. The idea is ingenious. The intervals between the wires were very regular in the machine examined; but it is possible that if a large grain of corn gets fixed in any part of the coil, the harmony of the spaces may be disturbed, and the action rendered defective.

Child's Patent Grain Separator was again seen at work, perfectly separating and sorting the grain, by its twofold blast and the exhausts. This machine is very largely used by the millers in this country to improve the samples of corn as purchased from the farmer, and since the latter can turn inferior grain to better account than any one else, it might be serviceable on any farm provided with fixed steam-power.

Among the Agricultural articles exhibited which belong to no definite class, none have more of a growing interest than the portable farm-railway. As steam-cultivation advances in clay-districts (in which materials for road-making are so often wanting), and superfluous horses are sold off, horse-labour will have to be economized even at a slack time of year. Moreover, the steam-cultivator will here help you to grow, but not to remove, large crops of roots. With the ordinary farm-track, as the traffic increases the difficulty of transport is augmented in a very much higher degree, until it becomes insuperable: whenever, therefore, the common cart and waggon are again under review, such a substitute as the tramway-truck and its movable road may deserve special attention.

Mr. Grant has made praiseworthy efforts to reduce the movable railway to its most simple elements: his continuous bearing upon the ground, his simple joint from the insertion of a projecting iron tongue on one rail into the iron mouth of the next; and lastly, his plain iron tie instead of a sleeper, are points which enable him to perform with much ease and despatch the removals which the branch-line of a farm-railway must be constantly undergoing. But it is questionable whether his system is not rather a substitute for the barrow than the cart; whether horse-traction can be well applied to it (and this is essential to economy), and also generally whether it is on a sufficiently large scale to be suited to the farm. It is satisfactory to know that its merits will be tested by an active agriculturist, who is prepared to make the venture, which involves an outlay of about 70*l.* for a quarter of a mile, or 110*l.* for half a mile of rail, with trucks, turn-table, &c.

For works on a larger scale in connexion with an iron tramway, the well known portable railway of the two Crosskill firms will probably hold its ground, or become as much in use in England as on large estates on the Continent, where roads are wanting and timber abundant.

Among the Miscellaneous articles which received medals or commendations, the wrought-iron ballasting Roller of Messrs. Aimes and Barford has the advantage that it travels light when empty, and, from its large diameter, easily overcomes an obstacle. The opening left for pouring in water is closed by a brass nut.

Maunder's Potato Separator may be thus described:—It consists of a riddle on an inclined plane, divided into two compartments floored with wooden laths (resting on rollers), which are placed at smaller intervals in the upper than in the lower portion. The smallest potatoes and the dirt fall through the first set of laths, and the dirt again drops through a screen-bottom in the lower chamber; the seed-potatoes fall through the floor in the second chamber; the large ones are carried to the end. Motion is given by a crank to the rollers, which make the laths vibrate sufficiently to keep the potatoes in motion; a wooden floor is necessary, that the potatoes may not be bruised. If this kind of screen were used for sorting stones for roads, iron-bars would probably be substituted for the wooden laths.

The novelty in the Patent Steerage exhibited by Wallis and Co. consists in its having but one wheel, so that a long lever-power is applied to but one fulcrum: the drill consequently answers the helm more quickly and easily.

Clarke and Sons' adjustable Scythe is neat and strong. A gardener will probably appreciate its merits, and so perhaps would a farm-labourer, if he were well-educated and careful.

Gower and Son in their combined Corn-distributor endeavour to dispense with the wheels and cups to regulate the feed. In their drill an eccentric gives a lateral motion to a bar placed in a trough (in which the corn is placed), having apertures at regular intervals in the bottom. The eccentric can be so adjusted as to vary the stroke of the bar, and therefore the amount of the feed. If grains were equal and symmetrical, we might anticipate uniformity of action; as it is, we must await a trial before arriving at any conclusion.

The merit of Bruckshaw's Cheese-press, as exhibited by Underhill, turns on its simplicity, whereby it occupies little room, and dispenses with weights, wheels, and levers.

The Excelsior Steel Whipple-trees carry their recommendation in the "steel," which is everywhere displacing wood, though, perhaps, with more marked advantage in other instances than in this.

Hornsby's Root-pulper will commend itself to the practical farmer by the character of its knives, or rather grinders, which are easily drawn (being stopped with wooden pegs), easily sharpened and reset, cheap and durable. Would that man's "dentition" was as effectual and accommodating! The root is well cleansed from dirt, and the last slice effectually disposed of.

XXIX.—Further Report of Experiments with different Manures on Permanent Meadow Land. By J. B. LAWES, F.R.S., F.C.S., and J. H. GILBERT, Ph.D., F.R.S., F.C.S.

THE object of the present Report is to give an account of the produce of hay per acre, the chemical composition of the hay, and the amount of certain constituents removed from the land, in the fourth, fifth, sixth, and seventh seasons of experiments on the application of different descriptions of manure, each applied (with some few exceptions or modifications) year after year on the same of a series of plots of permanent meadow land. The results obtained on the above points in the first, second, and third years, and on the variation in the description of plants developed in the third year, were given in vols. xix. and xx. of this Journal; and in the last Number (vol. xxiv., part 1) a detailed account of the description of plants developed by the different manures in the last or seventh season (1862), was given.

It is proposed to give the numerical results obtained during the last four years in regard to the points in question in some detail, but to comment on them much more briefly than it was found desirable to do when treating of the subject for the first time, in the Report above alluded to, to which we would refer the reader for a more detailed consideration of some of the points now discussed more briefly. We shall, however, give in the Tables a condensed summary of the results obtained over the whole seven years of the experiments, side by side with those of the later years, and in the course of our comments frequently compare the earlier and the later results.

The following is a detailed statement of the manuring of each plot; and, unless otherwise stated, it has been the same every year since the commencement of the experiments in 1856. The quantities per acre are given.

Plot 1. Unmanured.

Plot 2. Unmanured (duplicate plot at the further end of the series).

Plot 3a. Superphosphate of lime; composed of 200 lbs. of bone ash, and 150 lbs. sulphuric acid of sp. gr. 1·7. 4th season (commencing in 1859); sawdust alone the three previous years.

Plot 3b. Superphosphate of lime; and 400 lbs. ammonia-salts (equal parts sulphate and muriate of commerce, supplying about 82 lbs. nitrogen per acre). 4th season (commencing in 1859); the three previous seasons sawdust alone.

Plot 4. 400 lbs. ammonia-salts.

- Plot 5. 400 lbs. ammonia-salts, and 2000 lbs. sawdust.
Plot 6. 275 lbs. nitrate of soda of commerce (containing about 41 lbs. nitrogen). 5th season (commencing 1858).
Plot 7. 550 lbs. nitrate of soda (containing about 82 lbs. nitrogen). 5th season (commencing in 1858).
Plot 8. Mixed mineral manure, composed of—
 300 lbs. sulphate of potass.
 200 lbs. sulphate of soda.
 100 lbs. sulphate of magnesia.
 Superphosphate of lime, as above.
Plot 9. Mixed mineral manure, and 2000 lbs. sawdust. (The mixed mineral manure as plot 8 to 1861 inclusive, and in 1862 the sulphate of potass excluded, and the amount of sulphate of soda raised to 500 lbs.).
Plot 10. Mixed mineral manure, as plot 8, and 400 lbs. ammonia-salts.
Plot 11. Mixed mineral manure, as plot 9, 400 lbs. ammonia-salts, and 2000 lbs. sawdust.
Plot 12. Mixed mineral manure, as plot 8, 400 lbs. ammonia-salts, and 2000 lbs. cut wheat-straw.
Plot 13a. Mixed mineral manure, as plot 8, and 800 lbs. ammonia-salts, equal about 164 lbs. nitrogen (only 400 lbs. ammonia-salts in 1859, 1860, and 1861).
Plot 13b. Mixed mineral manure, as plot 13a, to 1861 inclusive; the same, with 200 lbs. silicate of soda and 200 lbs. silicate of lime in addition, in 1862, and 800 lbs. ammonia-salts (only 400 lbs. ammonia-salts in 1859, 1860, and 1861).
Plot 14. Mixed mineral manure, as plot 8, and 275 lbs. nitrate of soda. 5th season (commencing in 1858).
Plot 15. Mixed mineral manure, as plot 8, and 550 lbs. nitrate of soda. 5th season (commencing in 1858).
Plot 16. 14 tons farmyard manure.
Plot 17. 14 tons farmyard manure, and 200 lbs. ammonia salts.

The first crop each year has always been mown for hay, and the after-grass eaten off by sheep, once or twice as might be required, a certain number, according to the amount of grass, being folded on each plot, and the number of days occupied in its consumption noted.

Produce of Hay per acre (First Crop).

In Table I. (p. 530) are given the quantities of hay obtained per acre (first crop) from each plot in each of the four years, 1859, 1860, 1861, and 1862; also the average annual produce, and average annual increase by manure, over the four and over the

whole seven years of the experiments (1856-1862 inclusive). It is, of course, a matter of much interest to consider, not only the actual amounts of produce, or of increase, obtained from each of the differently manured plots, but also, whether the amounts increase or diminish year by year as the experiments proceed.

The duplicate unmanured plot, which was somewhat shaded from the afternoon sun, gave each year rather more produce than the other. Taking the mean of the two, the average annual yield of hay per acre, without manure, was, over the whole seven years, nearly $25\frac{1}{2}$ cwts., and over the last four years rather more than 26 cwts., showing that there is as yet no indication of progressive deterioration where only the natural produce of the soil and season is taken from the land. Nor is there as yet evidence of material falling off in gross produce in any case where artificial mineral manures were employed, notwithstanding that none of those used supplied every mineral or inorganic * constituent taken off in the increased crop. The details

* The terms "mineral" or "inorganic," as applied to the constituents of manures or crops, are, for convenience, employed throughout this paper to designate the incombustible or "ash constituents," they having been generally employed in this restricted sense by Liebig and most other writers on agricultural chemistry during the last twenty years or more. Yet, in his recent work (*Einkleitung in die Naturgesetze des Feldbaues*, p. 32 *et seq.*) Baron Liebig repudiates and ridicules such a classification as unscientific, claims ammonia and its salts as mineral manures, and accuses Mr. Lawes of setting up, in opposition to his own, a theory according to which mineral or inorganic manures should contain only incombustible or ash constituents. To support this allegation, he gives, in a separate paragraph, and in italics (*Sperrschrift*), the following sentence as a quotation from Mr. Lawes's paper on 'Agricultural Chemistry,' vol. viii. p. 240, of this Journal:—

"Manures are generally divided into two classes, organic and inorganic: organic manures are those which are capable of yielding to the plant, by decomposition or otherwise, carbon, hydrogen, and nitrogen. Inorganic manures are those substances which contain the mineral ingredients of which the ash of plants is found to consist."—[Translation.]

But the following is the passage as it really stands at the page referred to by Baron Liebig, and the portions given in capitals are those which are omitted by Baron Liebig in his professed quotation:—

"I NOW COME TO THE ACTION OF MANURES, WHICH ARE GENERALLY DIVIDED INTO TWO CLASSES—*organic* AND *inorganic*. ALTHOUGH THIS DISTINCTION IS BY NO MEANS SATISFACTORY, I SHALL ADOPT IT AS BEING GENERALLY UNDERSTOOD. Organic manures are those which are capable of yielding to the plant, by decomposition or otherwise, ORGANIC MATTER—carbon, hydrogen, oxygen, and nitrogen—CONSTITUENTS WHICH UNCULTIVATED PLANTS DERIVE ORIGINALLY FROM THE ATMOSPHERE. Inorganic manures are those substances which contain the mineral ingredients, of which the ash of plants is found to consist."

Here, then, in this which was Mr. Lawes's first paper, the classification which Baron Liebig accuses him of originating is only adopted as being already at that time "generally understood," and with a distinct protest that it is "by no means satisfactory." Yet, in order to fix the origination of the distinction upon Mr. Lawes, Baron Liebig joins together disconnected parts of a passage, and gives them, in a separate paragraph, in italics (*Sperrschrift*), and between unbroken inverted commas, omitting (besides less material portions) an entire sentence

given in our paper in the last Number of the Journal do show, however, that the description of plants developed has, in most cases, been much changed, and in some deteriorated, under the

which distinctly disproves the truth of the allegation in support of which the professed quotation is brought forward! Having thus moulded Mr. Lawes's sentence to suit the requirements of his argument, he goes on to say:—

"From this doctrine of the practical man it necessarily followed that a mineral manure must be one which contained *only* the ash-constituents of vegetable products, and from the composition of which ammonia-salts, as belonging to organic manures, are excluded. To be sure, in every chemical manual ammonia and its salts are treated of among inorganic substances, since they are objects of chemical manufacture, whilst organic matters cannot be produced by man; and this fact might well have led to the suspicion that ammonia was not necessarily excluded from an inorganic manure. The agricultural chemistry of the practical man was evidently a peculiar chemistry, which had no connexion with ordinary chemistry, and thus *his* theory might well find some justification, but according to *my* theory I obviously took another point of view. Mr. Lawes, indeed, mentions in his paper (p. 21), that my manures smelt of ammonia, and hence contained an ammonia-salt; but he implied that this might be a little artifice, in order to give to my manures an efficacy which, according to his interpretation of my theory, they should not possess."—[Translation.]

The following quotations, taken from several of Baron Liebig's works, will show whether he has not been accustomed to use the terms "mineral" or "inorganic" to designate the incombustible or ash-constituents, and to distinguish these from "ammonia," "ammoniacal salts," "atmospheric constituents," &c. The italicising is our own:—

"The *mineral* constituents act, as is shown by the produce of the unmanured land, without any artificial supply of *ammonia*."

"The *ammonia* increases the produce only if the *mineral* constituents be present in the soil in due quantity, and in an available form.

"*Ammonia* is without effect if the *mineral* constituents are wanting. Consequently, the action of *ammonia* is limited to the acceleration of the action of the *mineral* constituents in a given time."—*Principles*, pp. 86-7 (1855).

"..... the other is the action of *sulphate of ammonia* as a solvent for certain important *mineral* constituents of the soil."—*Ib.*, p. 99 (1855).

"*Ammonia*, when used as a manure alone, and when there is a want of *mineral* constituents in the soil, is like the spirits which the labourer takes in order to increase his available labour, power, or imagination; and, like that stimulant, its action, in this case, is followed by a corresponding exhaustion."—*Ib.*, p. 106 (1855).

"Hence it is quite certain that in our fields the amount of nitrogen in the crops is not at all in proportion to the quantity supplied in the manure, and that the soil cannot be exhausted by the exportation of products containing *nitrogen* (unless these products contain at the same time a large amount of *mineral* ingredients), because the *nitrogen* of vegetation is furnished by the atmosphere, and not by the soil. Hence also we cannot augment the fertility of our fields, or their powers of production, by supplying them with manures rich in *nitrogen*, or with *ammonia* salts alone. The crops on a field diminish or increase in exact proportion to the diminution or increase of the *mineral substances* conveyed to it in manure."—4th Edition, p. 210 (1847?).

"But, at the same time, it is of great importance for agriculture to know with certainty that the supply of *ammonia* is unnecessary for most of our cultivated plants, and that it may be even superfluous, if only the soil contain a sufficient supply of the *mineral* food of plants, when the *ammonia* required for their development will be furnished by the atmosphere."—4th Edition, p. 212 (213).

"A fertile soil must contain in sufficient quantity, and in a form adapted for assimilation, all the *inorganic* materials indispensable for the growth of plants.

"A field artificially prepared for culture contains a certain amount of *these ingredients*, and also of *ammoniacal salts* and decaying vegetable matter."—4th Edition, p. 169.

"The meaning of these sentences in my work is this: 'that *ammoniacal salts*

influence of the different manures; and those given further on relating to the chemical composition of the hay, and to the amount of constituents removed from the land, will lead to the conclusion that some of the manures have so forced the crop as materially to reduce the available store within the soil of some constituents which the manures themselves did not supply. On the other hand, even with 14 tons of farmyard manure per acre per annum, doubtless supplying annually much more of every mineral constituent than would be removed in the crop, the rate of increase is very little higher during the last four than during the whole seven years of the experiments.

With ammonia-salts alone (Plot 4) there has been an average increase over the seven years of about 8 cwts., and with ammonia salts and sawdust (Plot 5) of about 9 cwts. of hay per acre per annum; but over the last four years, of only about $5\frac{1}{2}$ cwts. with ammonia salts alone, and about $7\frac{1}{2}$ cwts. with the sawdust in addition. It is obvious, therefore, that, when ammonia salts were used year after year without mineral manure, there was an undue exhaustion of the mineral constituents of the soil. That this was so is confirmed, not only by the fact of the deteriorated character of the herbage, as shown by the results of the botanical examinations recorded in the last Number of the Journal, but also by the evidence relating to the chemical composition of the produce.

alone' have no effect; that, in order to be efficacious, they must be accompanied by the *mineral constituents*, and that the effect is then proportional to the supply—not of ammonia, but of the *mineral substances*.”—*Principles*, p. 55 (1855).

“These two paragraphs are altogether irreconcilable; for if Mr. Lawes admit that the *mineral constituents* are indispensable to plants, how can he maintain that these very *mineral constituents* are replaceable by ammonia, that is to say, that by means of ammonia we can altogether dispense with them?”—*Principles*, p. 82 (1855).

“It has been mentioned in the preceding part of the chapter, that animal excrements may be replaced in agriculture, by other materials containing their constituents. Now, as the principal action of the former depends upon their amount of *mineral food* so necessary for the growth of cultivated plants, it follows, that we might manure with the *mineral food* of wild plants, or, in other words, WITH THEIR ASHES [the capitals are Baron Liebig's own]; for, these plants are governed by the same laws, in their nutrition and growth, as cultivated plants themselves.”—3rd Edition, p. 183 (1843).

“But the weight or amount of the crops is in proportion to the quantity of food of both kinds, *atmospheric* and *mineral*, which is present in the soil, or conveyed to it in the same time. By manuring with *ammoniacal salts* a soil rich in available *mineral constituents*, the crops are augmented in the same way as they would have been if we had increased the proportion of ammonia in the air.”—*Principles*, p. 77-8 (1855).

These sentences will be sufficient to show whether or not Liebig is justified in now attempting to fall back, in agricultural discussions, upon the more strictly scientific meaning of the terms “*mineral*” and “*inorganic*,” so as to include within them “*ammonia*,” “*ammoniacal salts*,” “*atmospheric constituents*,” &c., and thus to give a new definition to his mineral theory, or rather substitute at this date for his own theory, which has proved to be erroneous, another not his own.

The experiments with nitrate of soda (Plots 6 and 7) were commenced two years later than those with the other manures, so that we have the results of only five instead of seven years to record. Unlike those with ammonia-salts alone, however, we have, so far, indication rather of progressive increase than decrease of annual effect. There is also, as yet, rather more of produce and increase from a given amount of nitrogen applied in the form of nitrate of soda (Plot 7), than from an equal amount in the form of ammonia salts (Plot 4). The description of plants developed was, moreover, very different in the two cases. These results may be partly due to the fact that the soil having less power to absorb and retain the nitric acid of the nitrate than the ammonia of the ammonia-salts, the former would probably be more rapidly diffused in the soil, and hence minister to the wants of plants whose roots take a wider range than those of the plants most benefited by ammonia salts.

The experiments with superphosphate of lime alone (Plot 3a), and with superphosphate of lime and ammonia-salts (Plot 3b), were commenced three years later than most of the others, so that the results recorded refer to the produce of four years only.

The average annual increase with the superphosphate of lime alone was little more than 2 cwts. of hay per acre; and the produce has fluctuated, from year to year, much in the same degree as that without manure, excepting that in the fourth season (1862) the produce scarcely exceeded the average without manure.

The addition of ammonia-salts to superphosphate of lime, raised the average annual produce from $28\frac{1}{2}$ cwts. to $43\frac{1}{2}$ cwts., and the average annual increase beyond the produce without manure from a little more than 2 cwts. to nearly $17\frac{1}{2}$ cwts.

When to superphosphate of lime, salts of potass, soda, and magnesia were added (Plot 8), the average annual produce was raised from $28\frac{1}{2}$ cwts. to $36\frac{1}{2}$ cwts. of hay per acre; but the increase under these circumstances consisted almost wholly, if not exclusively, of Leguminous plants—clovers, meadow vetchling, and bird's-foot trefoil. Both the average produce and average increase were rather higher during the last four years than over the whole seven years of the experiments, and there is as yet no sign of diminution. In fact, this "mixed mineral manure" supplied annually more of all the mineral constituents otherwise most likely to be exhausted than would be taken off in the increased produce of Leguminous plants.

The addition of sawdust to the mixed mineral manure (Plot 9) scarcely added at all to the produce. It should be observed, in regard to the manuring of this plot, that in 1862 the potass-salt was omitted, and a larger quantity of soda-salt substituted, and the result was (as shown in the last Number of the Journal)

a notable diminution in the proportion of Leguminous herbage, though the total yield of hay per acre was not diminished.

The addition of 400 lbs. of ammonia-salts (equal parts sulphate and muriate) to the mixed mineral manure of Plot 8 (Plot 10) increased the average annual produce over the last four years from $36\frac{1}{2}$ cwts. to $53\frac{1}{2}$ cwts. of hay, that is, by about $18\frac{1}{2}$ cwts; and the average annual increase obtained by this mixture, above the produce without manure, was nearly $28\frac{1}{2}$ cwts. over the last four, and rather more than $31\frac{1}{2}$ cwts. over the whole seven years. There is, therefore, when this large amount of ammonia-salt is used in conjunction with the mixed mineral manure, an indication of a slight falling off in the annual yield. In reference to this point it should be particularly borne in mind, that whilst the produce by the mixed mineral manure alone contained Leguminous herbage in amount equal to nearly one-fourth of its total weight, that grown by the mixed mineral manure and ammonia-salts contained scarcely a trace of such herbage. The produce in the latter case consisted (with the exception of a few luxuriant weeds), almost entirely of Gramineous plants, or grasses, properly so called, which require a large amount of silica for their development; and as the manure employed contained none, the large amount of increase must have caused a considerable drain of the available silica of the soil, the limitation of the supply of which probably set a limit to the amount of increase obtained by this otherwise heavy manuring.

The addition of 2000 lbs. of sawdust per acre per annum to the mixed mineral manure and ammonia-salts (Plot 11) very little affected either the amount or the character of the produce, which was, however, rather less than without the sawdust. On this Plot 11, as on Plot 9, the potass-salt was omitted from the manure in 1862, but the amount of soda-salt increased, and about 2 cwts. less hay were obtained than on Plot 10 with the potass and without the sawdust. This difference is, however, but small; and although (not having at present at command either the analytical details relating to the first crop, or the results relating to the after-grass) we do not record the amounts of the first crop of the present season (1863), it may be mentioned in passing that Plot 11, without potass, has this year given a somewhat larger amount of Gramineous hay than Plot 10 with it.

The general result in regard to the effects of these mixtures of mineral constituents and ammonia-salts (Plots 10 and 11) is, that, by their means, we have obtained for seven or eight years consecutively, an average produce of about $2\frac{1}{2}$ tons of hay per acre, and an average increase of about $1\frac{1}{2}$ ton.

Adding to the same mixture of mineral constituents and ammonia-salts 2000 lbs. of cut wheat-straw annually, scarcely

increased the average produce of hay, notwithstanding that the straw was calculated to furnish, by gradual decomposition, besides other mineral constituents, the silicates in which the artificial mixture was deficient, and to contribute a supply of carbonic acid for the solution of the mineral constituents of the soil, and a small amount of available nitrogen also. The after-grass has, however, generally been slightly more luxuriant; and, as shown in the last number of the Journal, the description of herbage developed was somewhat different, and, perhaps, rather superior.

On Plot 13 (divided in 1862 into 13*a* and 13*b*), in addition to the mixed mineral manure, there was applied a double or very excessive amount of ammonia-salts (800 lbs.) in the first, second, third, and seventh years of the experiments, but only 400 lbs. in each of the three intermediate years, 1859, 1860, and 1861. The result of this very heavy dressing was an average over the seven years of above 3 tons of hay per acre per annum. It was somewhat less during the last four years, in three of which the single amount only of ammonia-salts was used; but in 1862 (and in the present year also) the produce was again increased with the increased supply of ammonia-salts, though by no means in proportion to that increased supply. As shown in the last number of the Journal, the heavy crops grown on this plot contained not a trace of Leguminous plants; but, with the exception of a few very luxuriant weeds, they consisted almost entirely of comparatively few species of very free-growing grasses, in an over-luxuriant and very stemmy condition.

As just alluded to, in 1862, that is, after the experiments had been continued for six seasons, this Plot 13 was divided into two equal portions; and to one of these (13*b*) 200 lbs. of a silicate of soda, and 200 lbs. of a silicate of lime, were applied per acre, in addition to the manures of Plot 13*a*. This led to scarcely any appreciable increase in the first year of the application, but the results of the present or second season show an increased produce of about 6 cwts. of hay per acre where the silicates were used; and it was obvious to the eye that some of the grasses were more luxuriant. It remains to be seen what will be the effects of this addition in future years. There is no doubt that the heavy dressing of 13*a*, without silicates, forcing, as it does to such a degree, the luxuriant growth of Gramineous plants, which require more silica than herbage of any other description, must tax very severely the store of available silicates within the soil. Additional evidence will be given on the point further on; but it may be here remarked in passing, that the forcing of very heavy crops of hay by the use of artificial manures alone is by no means recommended.

It would be far too expensive to supply in this way all the constituents that are requisite for the production of such crops without undue exhaustion of the soil, or deterioration in the character of the herbage. Artificial manures can, as a rule, only be used with advantage and economy for the hay crop, when the land receives periodically a dressing of stable or farmyard manure. Such manure restores the mineral constituents taken from the land in the crop more completely, and some of them more economically, than any other; it at the same time supplies a large amount of available nitrogen, and of organic matter yielding by its decomposition carbonic acid, and is calculated to favour a more complex and generally a superior description of herbage.

Plot 14 received the same description and amount of mineral manure as Plots 8, 10, 12, and 13a, and, in addition, nitrate of soda containing about half the amount of nitrogen supplied in the ammonia-salts of Plot 10; and Plot 15, with the same mineral manure, had, in addition, double the amount of nitrate—that is, about the same amount of nitrogen as that in the ammonia-salts of Plot 10. These experiments, like those with nitrate of soda alone, were commenced only in 1858, two years later than most of the series. The figures show an average over the five years of 44 cwts. of hay per acre per annum with the smaller amount of nitrate, and the mineral manure, and of $51\frac{1}{2}$ cwts. with the larger amount, against $56\frac{1}{2}$ cwts. with the same mineral manure, and ammonia-salts equal in nitrogen to this larger amount of nitrate.

Ammonia-salts, in conjunction with the mixed mineral manure, have, therefore, given a larger amount of produce than an equal amount of nitrogen in the form of nitrate of soda. The description of herbage developed was, however, strikingly different in the two cases, and very different also with the smaller and the larger amounts of nitrate, as will be found by reference to the last number of the Journal. It should be added, that there is as yet no evidence of diminution of produce from year to year where the nitrate (either in the larger or the smaller quantity) was used in conjunction with the mixed mineral manure.

The plots manured with farmyard manure remain to be considered. The amount annually supplied (14 tons) would contain more of every mineral constituent, and considerably more nitrogen, than the produce obtained by its use, besides a large quantity of organic matter yielding by its decomposition carbonic acid and other products. When the farmyard manure was used without the addition of ammonia-salts, the average annual produce amounted to only about $42\frac{1}{2}$ cwts. of hay, or to less than 1 ton above that without manure, and to considerably less than was

obtained by the most active artificial manures. The description of herbage was, however, very different—that grown by the farmyard manure being very much more complex and, upon the whole, superior in quality to that grown by the very active artificial Manures.

The addition of 200 lbs. of ammonia-salts to the comprehensive, but not very rapidly active, farmyard manure increased the average annual produce by only about 6 cwts. of hay; still, therefore, giving a produce considerably less than that obtained by the most active artificial manures. Nor did the addition of ammonia-salts improve the character of the herbage, which was more Graminaceous, consisted in larger proportion of comparatively few species, and was much more stemmy, than when the farmyard manure was used alone. The number, and proportion in the produce, of miscellaneous or weedy plants was, however, considerably reduced under the influence of the ammonia-salts.

Reviewing the results of the whole series, it is observed that the average produce without manure is slightly higher over the last four than over the whole seven years of the experiments; indicating, therefore, that the conjoint resources of soil and season were at least equal, if not more favourable, during the later years. A similar result is observed in the case of the farmyard manure plot, and of the plots where there was a liberal supply of mineral constituents without ammonia in the artificial manures; but where ammonia-salts were used in large quantity, either alone or in conjunction with the mineral manures, there was a tendency to a rather diminished rate of increase as the experiments proceed. The indication, so far as the gross amount of hay obtained is concerned, is, however, as yet but slight; and in the present season (1863) the produce on Plot 13a, where the very excessive amount of ammonia-salts was used, and where the mineral manure contained no silicates, is heavier than in any previous season. The chief indication of exhaustion of certain constituents, or of deterioration of the produce, is afforded by a consideration of the description and composition of the herbage developed. Where nitrate of soda is used, whether alone or in conjunction with the mixed mineral manure, there is as yet no evidence of progressive falling off in the annual yield.

Produce of After-Grass.

Table II. (p. 531) shows the amounts of hay per acre to which the after-grass of each of the last four seasons is estimated to be equivalent, and also the annual average over the four and over the seven years of the experiments. As already mentioned, the after-grass was always consumed by sheep (once or twice, as might be

required), so that the estimation of the quantity of hay to which it corresponded is necessarily a matter of calculation merely. The plan adopted was—to fold sheep on each plot, the number depending upon the amount of grass; to move the hurdles day by day as required; to note the time taken to consume the produce; and then to estimate, approximately, the amount of hay to which the consumed grass was equivalent, on the assumption that each sheep would, on the average, consume grass equal to 16 lbs. of hay per head per week. Such an estimate, though only approximate, still affords a very useful indication of the relative, if not the actual, amounts of after-grass of the respective plots. In 1860 and 1862 it was so eaten off twice, but in each of the other years only once.

It will be obvious that, as the animals would return to the land by far the larger proportion of both the mineral constituents and the nitrogen of the produce, to serve as manure for the first crop of the succeeding season, and so on each year, the amounts of hay estimated as above described cannot be added to the actual amounts of the first crop, and the sum reckoned as the annual yield on the respective plots. The latter would, however, it is true, be somewhat higher than the amount of first crop hay alone.

Judging from the relative amounts of first-crop hay where the mineral constituents would probably be in relatively large amount (without manure, with purely mineral manure, or with farmyard manure, for example), and where, therefore, the produce would be the more directly limited by the conditions of season, it would be concluded that these were the least favourable in 1859, more so in 1860, and still more favourable, and about equally so, in 1861 and 1862. Judging, in the same way, from the estimated amounts of hay corresponding to the after-grass, it would appear that the period of its growth was the most favourable in 1860, and nearly equally so in 1862 (these being the two years in which the produce was eaten off twice), that it was somewhat less favourable in 1861, and less so still in 1859. But it is obvious that the influence of accumulation, or of non-exhaustion of previous manuring, as well as that of season, has to be taken into account as affecting the produce in one year compared with another. The less the exhaustion of the more active manurial constituents by the growth of the first crop, the greater will be the accumulation for the after-growth, though their activity will greatly depend on the climatic conditions. And, again, variations in the amount of after-grass will affect the amount of manure left by the animals on the surface of the land, to be washed in and serve for the first crop of the succeeding year; though it will be obvious that any effects of such variation will

be due to the condition and distribution of the constituents rather than to any actual loss or gain of them.

The produce of after-grass was, upon the whole, the largest in 1860, when it was eaten off twice—the first time early in September. In accordance with this, the records show that in the months of July and August the maximum temperature was comparatively low, the minimum temperature moderate, the mean temperature and the range of temperature both low, and the fall of rain and the number of days on which it fell above the average. In 1862, also, the grass was fed off twice, commencing the first time soon after the middle of August; and the characters of the July and August of that season more nearly approached those of 1860, as above quoted, than did those of either of the other years. In 1859 the after-growth was both the smallest in amount and the latest, the sheep not being put upon the land at all until November 14; and coincidentally with this there was comparatively high temperature, and somewhat below the average amount and distribution of rain—especially during the first few weeks after the removal of the hay-crop. In 1861 the amounts of after-grass were more than in 1859, but less than in either 1860 or 1862, and the produce was eaten off only once—namely, early in October. The characters of the season in regard both to temperature and amount of rain were less favourable for succulent growth than in either 1860 or 1862, and as to amount of rain less favourable than in 1859 also. In regard, however, to the distribution of rain, or the number of days on which it fell, the month of July (1861) was far above, and that of September about, the average.

From these few observations it will be obvious that the variations in the amounts of after-grass in one year compared with another were very directly dependent on the characters of the seasons; they were, in fact, much more so than on the greater or less amounts of hay removed in the first crop. It is, indeed, remarkable how little was the fluctuation in the produce of first-crop hay from season to season, with one and the same manure, compared with that of the after-grass. The character of the herbage of the first crop was, however, remarkably affected by the character of the season of its growth; one and the same amount of produce representing a very different description of hay in the different years. The variation manifested itself not only in a difference in the prevalence of particular plants, but more strikingly in the character of their development—the relative tendency to give a leafy or stemmy, base-leaved or stem-leaved, early or late, ripe or unripe produce. But the gross amounts of after-grass varied exceedingly from

year to year. In 1860 they amounted on the average to twice as much as in 1859; in 1861 to considerably less than in 1860, but generally to at least $1\frac{1}{2}$ time as much as in 1859; and in 1862 in most cases to nearly as much and in some to considerably more than 1860.

Without manure, the after-grass of 1859 was estimated as equal to something less than 8 cwts., that of 1860 about 19 cwts., that of 1861 nearly 14 cwts., and that of 1862 about $15\frac{1}{2}$ cwts. of hay. With farmyard manure the amounts were scarcely 10 cwts. in 1859, more than $21\frac{1}{2}$ cwts. in 1860, nearly 16 cwts. in 1861, and over 21 cwts. in 1862. With the heavy dressings of mixed mineral manure and ammonia-salts they ranged from about 11 to nearly 15 cwts. in 1859, from over 21 to over 22 cwts. in 1860, from about 16 to about 18 cwts. in 1861, and from about 17 to about 24 cwts. in 1862.

Comparing more directly the effects of the different manures on the amounts of after-grass, it is seen that the quantities varied, in 1859 from under 8 cwts. without manure to about $14\frac{3}{4}$ cwts. with the heaviest artificial manuring; in 1860 from about 19 cwts., to about 22 cwts.; in 1861 from about $13\frac{3}{4}$ cwts. to over 18 cwts.; and in 1862 from about $15\frac{1}{2}$ cwts. to about $24\frac{1}{2}$ cwts.

The facts relating to the after-grass show, then, that the amounts varied very much both according to season and manuring, and that, when both were favourable, they were frequently equivalent to more than one ton of hay. Taking the average of the seven years, the after-grass without manure was estimated as equivalent to about $12\frac{1}{2}$ cwts. of hay per acre per annum, and that with the heaviest artificial manuring at nearly $19\frac{1}{2}$ cwts.

Chemical Composition of the Hay.

In our former report on the composition of the hay grown by the different manures in the earlier years of the experiments (vol. xx., part 2), we treated of the proportions of—nitrogenous substance, fatty matter, woody fibre, other non-nitrogenous vegetable compounds, mineral matter (ash), total dry substance, and water; and to that more complete consideration of the subject we refer the reader. In treating, on the present occasion, of the composition of the hay grown in the fourth, fifth, sixth, and seventh seasons, attention will be confined to the proportions of dry matter, of mineral matter (ash), and of nitrogen; and a few general observations on the circumstances affecting the composition may here be made, thereby rendering the indications of the results themselves the more readily understood.

Comparing the hay of one season with that of another, a high

percentage of dry matter may simply indicate dry weather at the time of cutting and during the making ; or, it may also indicate a relatively high degree of maturity or ripeness. Comparing the produce of one plot with that of another differently manured, but grown in the same season, and cut and made under the same conditions of weather, a relatively high percentage of dry substance indicates a comparatively high degree of ripeness or maturity, and most probably a stemmy rather than a leafy condition of development.

As the percentage of mineral matter or incombustible constituents, even though the same in the fresh hay, may be very different in its dry substance, according to the proportion of the latter, and as the percentage in the dry substance indicates much more clearly the probable condition of the hay, it is important that it, as well as that in the fresh hay, should be considered. Other things being equal, a high percentage of mineral matter in the dry substance indicates a leafy rather than a stemmy development, and an immature rather than a ripe condition. The percentage of mineral matter in the produce is also more or less, though comparatively slightly, affected by the liberality or deficiency of available mineral constituents within the soil ; but as the tendency of the development is very much affected by these circumstances, the effects are, in part at least, indirect ; that is to say, the relative supply of mineral constituents, affecting as it does the relative development of leaf and stem, and the tendency to ripen, the percentage of mineral matter in the produce is in its turn affected accordingly, as above referred to.

The percentage of nitrogen in the dry substance of the hay may depend on several different conditions. The condition of manuring being the same, a high percentage in the produce of one year compared with that of another will most probably indicate a high proportion of leaf to stem, or a green and succulent rather than a ripened condition. Comparing the produce by one manure with that of another in one and the same season, the percentage may again depend on various circumstances. Leguminous plants, and some weeds, are much richer in nitrogen than Gramineous plants in an equal condition of ripeness ; leafy matter generally contains a higher percentage than stemmy ; succulent and unripe produce a higher one than that which is ripe (all of which conditions are much influenced by the character of the manure) ; and further, when in the succulent and unripe condition, as produce cut for hay to a certain extent is, the percentage of nitrogen is generally pretty directly affected by the relative available supply of it within the soil. That is to say, an excessively nitrogenous manure will—other things being equal—give a relatively high percentage of nitrogen at an

equal stage of growth or maturity; but as, within limits, and under favourable conditions of soil and season, a moderate supply of nitrogen favours the ripening tendency, the crop more liberally dressed with nitrogenous manure may, at the same period of time, be at a more advanced stage of growth, and it might not then, as it otherwise would, show a higher percentage of nitrogen in its dry substance.

Percentage of Dry Matter in the Hay.

Table III. (p. 532), gives, for each plot, the percentage of dry matter in the hay as carted from the land, in each of the last four years, also the average percentages over the four, and the whole seven years of the experiments.

Comparing the produce of one year with that of another, the order of highest percentage of dry matter was—1859, 1861, 1860, and 1862; and it may be observed that this result is quite consistent with the characters of the respective seasons for some time before cutting, and during the making the hay. The percentages of mineral matter in the dry substance will, however, show, that there was a real difference in the ripeness of the produce, as well as in its mere condition of dryness or dampness according to the weather immediately before the cutting and during the making. Thus, the produce of 1859 and 1861, with higher percentages of dry matter than in that of 1860 or 1862, contained lower average proportions of mineral matter in the dry substance, indicating a greater degree of maturity.

The percentage of dry matter in the produce varied very much less comparing that grown by different manures in the same season, than comparing season with season. In fact, when it is borne in mind how many circumstances affect the condition of such complex and indefinitely ripened produce as hay according to the manure employed, it is only what we should expect, to find that the difference in the condition of the produce of two comparable plots may vary, or even be reversed, according to the characters of the season; for, not only will the proportions of Leguminous, Gramineous, or other herbage (which are each somewhat differently affected in development according to season) be very different according to the manure employed, but the prevalence of one Gramineous plant over another, the tendency to leafy or stemmy growth, and the relative condition of ripeness, will also greatly vary. Thus, with a hot and ripening season, the addition of nitrogenous to mineral manure may so increase the fixation of carbonaceous substance as to give a produce containing a higher proportion of dry substance; whilst in a wetter and colder season the effect would probably be to give a relatively leafy and succulent

growth, containing a lower percentage of dry matter. Accordingly, the relative proportions of dry matter in the produce of one plot compared with that of another are seen to vary more or less from season to season. Still the general, though not the invariable, result is found to be that, in comparable cases, the larger the relative supply of available mineral constituents, the higher will be the percentage of dry matter in the produce at the time of cutting, due mainly to the greater tendency to ripen under such conditions. The columns showing the average percentage of dry matter in the produce of each plot over the four and over the seven years afford sufficient illustration on this point.

The general result in regard to the proportion of dry matter in the hay is, that variation of season has very much more influence than variation in manure in one and the same season; that, so far as manures have an influence, those which tend most to stemmy produce, and to ripeness, generally give the highest proportion of dry substance; that a relatively liberal supply of mineral manure favours this tendency; and, that the greater the excess of nitrogenous manure (provided the supply of mineral constituents be not insufficient for luxuriant growth), the lower, other things being equal, will be the proportion of dry matter in the produce.

Percentage of Mineral Matter (Ash) in the Hay.

Table IV. (p. 533) shows the percentages of mineral residue obtained on burning the dry substance to ash, and the results approximately represent the relative proportions of mineral constituents. The left division gives the percentages in the hay as taken from the land, and the right those in the dry substance of the hay. The latter of course give the best view of the relations of the mineral to the other solid constituents of the produce.

Comparing season with season, there were much lower proportions of mineral matter in the dry substance of the riper and drier produce of 1859 and 1861, than in that of the more backward and moister produce of 1860 and 1862; and, of the four seasons, the produce of 1862, which yielded the lowest proportion of dry substance, shows generally, but not invariably, the highest proportion of mineral matter in that dry substance.

Comparing plot with plot, the percentage of mineral matter in the dry substance of the hay has a very obvious connexion with the conditions and characters of growth.

The general result in regard to the proportion of mineral matter in the dry substance of the hay may be stated to be, that it was the higher the more liberal the relative supply of mineral constituents in the manure, the less Gramineous, or the less

ripe, the produce, and that it was lower in the opposite conditions. Combinations of these several conditions (the two latter of which are each much influenced both by season and manure) determine the actual character of the produce in regard to the point in question.

Percentages of Nitrogen in the Hay.

Table V. (p. 534) shows the percentages of nitrogen in the produce of each plot in each of the four years under consideration, also the average over the four years, and the average over the seven years; the left hand columns give the proportions in the hay as taken from the land, and the right hand ones those in the dry substance of the hay.

It has been already stated—that Leguminous produce, in an equal condition of ripeness, gives a higher percentage of nitrogen than Gramineous produce; that, other things being equal, the more leafy or more unripe the crop, the higher will be the percentage of nitrogen in the dry substance; and that, in succulent and unripe produce more especially, the proportion may be much increased by a liberal or an excessive supply of nitrogen in manure. Keeping in view these few facts, the variations exhibited in the Table become intelligible; and it will be observed that they are less directly traceable to the characters of the seasons, and much more dependent on variation in manuring, than are those of either the dry substance or the mineral matter.

In fact, the general result may be stated to be, that there was much less difference from year to year depending upon season, than between the produce of different plots in one and the same season depending on difference in manuring; that, other things being equal, the more complex and the less Gramineous the herbage (conditions favoured by mineral manures), the more leafy, the less ripe, and the more excessive the nitrogenous manuring, the higher was the percentage of nitrogen; that the more Gramineous, the more stemmy, and the more ripe (conditions favoured by farmyard-manure, and by artificial combinations of both mineral and nitrogenous manure), the lower was the percentage of nitrogen.

It was fully explained in our former paper on this subject, that a percentage of nitrogen in meadow-hay much beyond that found in the produce grown without manure, or by farmyard-manure, is by no means a sure indication of a proportionally increased amount of matured and digestible or assimilable nitrogenous substance. When the increased percentage of nitrogen is due to a large proportion of Leguminous herbage, it will probably indicate a large proportion of nutritive nitrogenous

compounds; but when it is the result of excessive nitrogenous manuring, the produce is then almost exclusively Gramineous and comparatively immatured; and, under such circumstances, a certain portion of the nitrogen may exist in a low condition of elaboration, and a high proportion may, in fact, represent a deficient accumulation of other matters rather than a favourable development of nutritive nitrogenous substance. A percentage of nitrogen in meadow-hay beyond that obtained without manure or by means of farmyard-manure is, therefore, under such conditions, not to be taken as evidence of higher feeding value. The value of the manure voided by the animals feeding on the hay, will, however, be the higher the higher the proportion of nitrogen it contains—especially as it so happens that there is generally with a high percentage of nitrogen a high percentage of mineral matter also.

Produce of Constituents per Acre.

As pointed out in our former report, particular interest attaches to the question of the amount of constituents taken from an acre of land in the hay-crop, because very frequently the system of restoration adopted in the case of the meadow-land of a farm is even less satisfactory than in that of the land under rotation; hence it becomes necessary to impress upon the farmer how great is the exhaustion to which his meadow-land may be subject.

Tables VI., VII., and VIII. (pp. 535-6-7) show, respectively, the amounts of dry substance, of mineral matter, and of nitrogen, removed per acre from each of the experimental plots, in each of the last four years; also the average amounts per annum, both in the produce and in the increase by manure, over the four years, and over the whole seven years of the experiments.

Over the seven years, there has been removed per acre annually from the unmanured land an average of 2358 lbs. (about 21 cwts.) of dry substance, containing 167½ lbs. (1½ cwts.) of mineral matter, and nearly 40 lbs. of nitrogen. This amount of dry substance is somewhat higher than the average of the first three years of the experiments; but it agrees very closely with, though it somewhat exceeds, the amounts annually taken from the land in wheat or barley grown year after year without manure. The above amounts of mineral matter and nitrogen are, however, each fully one-half more than are removed in wheat or barley grown under such circumstances.

The unmanured produce of hay would contain between 900 and 1000 lbs. of carbon. By the use of ammonia-salts alone, or

nitrate of soda alone, the amount of carbon annually removed in the crop was increased to something under or over 1300 lbs., and by means of the mixed mineral manure alone to about the same amount; but by the mixtures of both ammonia-salts and mineral manure it was increased to over 2000 lbs. per acre—that is, without any supply of carbon in the manure. The addition to the latter manures of 2000 lbs. of sawdust, or 2000 lbs. of cut wheat-straw, each containing in round numbers about 700 lbs. of carbon, gave no increased yield of it in the produce. Nor did farmyard-manure, in amount containing at least twice as much carbon as the crop yielded by its use, give a produce containing more than about three-fourths as much as the mixtures of mineral manure and ammonia-salts which supplied none. It may be concluded, therefore, that, even admitting that the carbonaceous manures did supply carbon to the growing plants, the supply from that source was at any rate unnecessary, provided only that mineral or incombustible constituents, and nitrogenous manures were liberally supplied.

As mentioned above, the average amount of mineral or incombustible constituents taken from the land without manure was, over the seven years, $167\frac{1}{2}$ lbs., or about $1\frac{1}{2}$ cwts. per acre per annum. The amount removed in the crop grown by means of ammonia-salts alone was increased to something under, and that by nitrate of soda alone to something over, 2 cwts.; there being, therefore, by such manuring, a further drain upon the resources of the soil.

By means of the mixed mineral manure alone, the amount of incombustible constituents taken away in the crop was raised to about $2\frac{1}{2}$ cwts.; but the manure itself supplied more of almost every such constituent, except silica, than the entire produce would contain; so that, excepting in the item of available silica, the soil was, compared with the unmanured land, annually accumulating most of the important mineral constituents. By the addition of ammonia-salts to the mixed mineral manure, the amount of mineral constituents taken from the land was raised from about $2\frac{1}{2}$ to nearly $3\frac{1}{2}$ cwts. when the smaller amount (Plot 9), and to nearly 4 cwts. when the larger amount of ammonia-salts (Plot 13a) was employed; and, as the produce was in these cases almost entirely Gramineous, the drain upon the available silica of the soil would be very considerable; though, here again, all the other incombustible constituents were supplied in far larger quantity than they were taken off in the crops. By the addition of nitrate of soda to the mixed mineral manure, whether in the smaller amount (Plot 14), or in the larger amount

equal in nitrogen to the ammonia-salts of Plot 9 (Plot 15), the quantity of mineral constituents taken from the land was somewhat less.

Lastly on this point : by means of an annual dressing of farmyard-manure, doubtless supplying much more of every mineral constituent than was contained in the crop yielded, rather under 3 cwts. of incombustible constituents were annually taken from the land ; and, when to the farmyard-manure ammonia-salts were added, the amount was raised by only 43½ lbs.—that is, from 328½ to 372½ lbs., or to less than when the artificial mixtures of mineral manure and ammonia-salts were employed.

The result is, then, that without manure the land yielded, over seven years, about 1½ cwt. of mineral constituents per acre per annum, the amount increasing rather than diminishing in the later years ; that farmyard-manure supplying, besides other matters, more of every mineral constituent than the produce obtained by its use, gave a crop containing about twice as much ; and that artificial mixtures containing both mineral constituents and ammonia-salts gave a still larger yield, even when no silicates were supplied in the manure.

It is obvious, that when purchased nitrogenous and phosphatic manures, such as Peruvian guano, or mixtures of ammonia-salts or nitrate of soda and superphosphate of lime, are alone relied upon for the increased crop of hay, the drain of potass and available silica from the soil must be very great. This was illustrated in some detail in our former report, by reference to the analyses of the ashes of the hay grown by the different manures ; and confirmatory evidence of the injurious effects of such exhaustion will be found on comparing the average annual amounts of mineral matter taken from each plot over the seven with that over the last four years. Thus, whilst without manure, with mixed mineral manure, and with farmyard-manure, the average amount of mineral constituents annually taken from the land was greater during the later years than during the whole period of the experiments, it was (with one exception) less in the later years wherever large quantities of ammonia-salts were employed. A similar result is not as yet observable when nitrate of soda has been used ; but, as already explained, it is probable that some of the plants then developed would draw their nutriment from a more extended range within the soil ; and, if so, a diminution in the annual yield may be only a little postponed.

These results in regard to the mineral constituents taken from the land in the hay crop, clearly show how important it is that due restoration should be made, if the character of the herbage and the amount of crop are to be maintained. This is best accomplished in practice by an occasional dressing of well-rotted

stable or farmyard-manure. Taking into account the other constituents at the same time thus supplied, silica and potass are more advantageously and economically provided in this form than in any other; and, as the results with the farmyard-manure show, the increase which a given quantity annually yields, removes but a small amount of mineral constituents compared with that which it supplies, so that the effects extend over several years, causing, unless specially nitrogenous manures be also applied, an accumulation within, rather than an exhaustion of the soil. When farmyard-manure is so employed, a further increase of crop may, without detriment to the land, be annually obtained by the moderate application of the current artificial manures containing nitrogen and phosphoric acid; but to this point we shall recur presently.

Produce of Nitrogen per Acre.

Table VIII. (p. 537) shows the acreage amounts of nitrogen taken off in the crop of each plot, in each of the last four years, also the average annual yield, and the average annual increase of it, over the last four, and over the whole seven years. A comparison of the two columns, giving the annual average yield, shows that, in the majority of cases, it was almost identical over the last four, and the whole seven years. The agreement was the less close where the large amounts of ammonia were used in conjunction with mineral manure, by which very large crops were obtained. It is, however, only in the case of Plot 13a, where the very excessive amount of ammonia-salts was applied in the first, second, third, and seventh years, that the average yield of nitrogen is at all materially reduced during the last four, as compared with the seven years (98.3 lbs. to 85.8 lbs.). But, as the supply of nitrogen in the manure was reduced by one-half in three years out of the four, this is only what might be expected; and it is seen that, in the seventh year, when the larger amount of ammonia-salt was again employed, the yield of nitrogen per acre in the crop was considerably increased.

Taking the average over the seven years, the result is—that the yield of nitrogen per acre without manure was within a fraction of 40 lbs., or about $1\frac{1}{2}$ time as much as has been annually taken from an acre of unmanured land in either wheat or barley; that mineral manures alone increased the yield by nearly one-half, the increase being then due to the large amount per acre, and proportion in the produce, of the highly nitrogenized Leguminous herbage; that ammonia-salts alone (or nitrate of soda containing about an equal amount of nitrogen) increased it more than mineral manures alone, though Leguminous plants were then almost excluded, and the produce was almost wholly Grami-

naceous ; and that the mixtures of mineral manure and ammonia-salts (or nitrate supplying an equal amount of nitrogen), which gave a very much increased, and also an almost exclusively Gramineous produce, gave also the highest yield of nitrogen in the series—even more than a mixture of farmyard-manure and ammonia-salts, together supplying much more nitrogen.

The important question arises—What proportion of the nitrogen supplied in the manure is recovered as increased yield of it in the crop?

Proportion of the Nitrogen supplied in the Manure which is recovered as increased yield of it in the Crop.

In our former Report, with the average results over only three years before us, we showed that, under the most favourable conditions, the increased yield of nitrogen in the hay-crop scarcely reached, and in the average of cases fell short of, 50 per cent. of that supplied in the manure. But it was admitted that three years was too short an experience upon which to form a satisfactory estimate on the point. The calculations have now been made for the whole seven years of the experiments.

In Table IX. (p. 538) are recorded the actual amounts of nitrogen per acre (lbs.), and in Table X. (p. 539) the amounts for 100 in manure, which were recovered as increased yield of it, when known quantities were supplied, each being reckoned both over the yield without manure, and over that by mixed mineral manure alone ; and, for comparison, the average results over both the last four and the whole seven years are given.

It is obvious that, in a practical or economical sense, the only direct gain to the farmer of nitrogen in the produce by the use of mineral and nitrogenous manures together, is so much as is over and above the amount yielded by the same mineral manures when used alone. But, for reasons explained in our former Report, we deem it, upon the whole, the most consistent with what we know of the facts, to reckon at least so much of the nitrogen of the produce grown by nitrogenous manure as is over and above that yielded without manure, to have its source in the nitrogen supplied, whether the nitrogenous manure be employed alone, or in conjunction with mineral manure.

Reckoned in this way, Table X. shows that, when ammonia-salts were used alone (Plot 4), 27·4 per cent. only of the nitrogen so supplied was recovered as increased yield over the seven years, and very nearly the same proportion, 27·1 per cent., over the last four years. With salts of ammonia and sawdust (Plot 5), reckoning of course the nitrogen in the sawdust, the proportion recovered was rather less, but again about equal over the seven and the last four years. With the smaller amount of

nitrate of soda (Plot 6), the estimated return of nitrogen was 37.7 per cent., and with the larger amount (Plot 7) only 29.9 per cent, taking the average of the five years of its use; but over the last four years the figures show rather more recovered than when the first year is included. It is worthy of remark, that the proportion recovered with the larger amount of nitrate (Plot 7), is higher than with the corresponding amount of nitrogen in the form of ammonia-salts (Plot 4).

With the same amount of ammonia-salts as was applied to Plot 4 (400 lbs.), and the mixed mineral manure in addition (Plot 10), the increased yield of nitrogen estimated as attributable to that supplied was 46.5 per cent. reckoning over the seven, but only 43.4 per cent. over the last four years; indicating, therefore, that, even under these comparatively favourable conditions, the proportion recovered is diminishing rather than increasing from year to year. It is to be borne in mind, however, not only that the silica so specially required by Gramineaceous crops was not supplied in the mineral manure in question, but also that the amount of ammonia-salts annually used (400 lbs., containing about 82 lbs. nitrogen) was very large. It is remarkable, too, that although when used alone (Plot 4), the ammonia-salts gave a less return of nitrogen than nitrate of soda containing an equal amount of it (Plot 7), yet, when used in conjunction with the mixed mineral manure, the proportion estimated as recovered was less with the nitrate (Plot 15) than with the ammonia-salts (Plot 10). However, when the smaller amount of nitrate of soda was used with the mineral manure (Plot 14), the nitrogen estimated as recovered amounted to about 62 per cent. of that supplied; that is, to more than in any of the experiments where the larger amounts of nitrogen were supplied, which gave larger, though not proportionally larger, amounts of produce.

When to the mixed mineral manure and ammonia-salts, sawdust or cut wheat-straw (Plots 11 or 12) was added, and their nitrogen reckoned in the supply, the proportions estimated as recovered are less than when they are not employed.

Where the double or very excessive amount of ammonia-salts was applied in the first, second, third, and seventh years (Plot 13a), the proportion of nitrogen recovered was exactly the same over the seven years (and even more over the last four) as where the less amount of ammonia-salts with the same mineral manures was used (Plot 10). The increase of gross produce or hay was, however, not in proportion either to the increased supply or increased yield of nitrogen; the large yield of it being due to a very high—perhaps an objectionably high—percentage in the produce in the years in which the large amount

of ammonia-salts was used; in fact, it was then higher than in any other case where mineral manures were used in conjunction with ammonia-salts. The Table records the results of only one year (1862) in which, to this mixture of 800 lbs. of ammonia-salts and the "mixed mineral manure," silicates (so much exhausted by the hay crop) were added (13*b*), and the figures show almost exactly the same proportion of nitrogen recovered as in the same year without the silicates (13*a*).

Lastly, when ammonia-salts were added, in comparatively small or moderate amount, to a quantity of farmyard-manure itself containing a very large amount of nitrogen, the increased yield of nitrogen beyond that in the produce by farmyard-manure alone amounted, over the seven years, to only 21·9 per cent., and over the last four years to only 13·8 per cent. of that supplied in the ammonia-salts. It may be further remarked that, if the farmyard-manure employed be assumed to have been of fair average composition, the proportion of its nitrogen reckoned as recovered in the increased yield (beyond that without manure), reaches to even a still lower amount.

To sum up on this point, the average results taken over the seven years are, that, when the nitrogenous manures (ammonia-salts or nitrate) were used alone 29·9, and when in conjunction with the mixed mineral manure 45·1 per cent. of the supplied nitrogen were reckoned as recovered as increased yield of it in the crop. In our former Report, then taking the results of three years only, the amounts were 26·1 per cent. without, and 46·6 per cent. with the mineral manure. The result over the more extended period is, therefore, somewhat higher without, and somewhat lower with, the mineral manure. When ammonia-salts were superadded to an amount of farmyard-manure doubtless containing nitrogen, carbon, and every mineral constituent, in larger quantity than the crop it yielded (though in comparatively slowly available condition), the increased yield of nitrogen due to the ammonia-salts was then less than in any of the other conditions of their use; and it was considerably less over the later than over the earlier years. It may be remarked that nitrate of soda containing the same amount of nitrogen as that in the ammonia-salts added to the farmyard-manure, but used in conjunction with the mixed mineral manure, was reckoned to return nearly three times as much of the supplied nitrogen.

Before leaving the question of the amount of nitrogen estimated as recovered in the increase for a given amount supplied in manure, it should be observed that, inasmuch as the whole of the nitrogen of the after-grass is not returned to the land by the animals fed upon it, the amount will be

somewhat higher than that represented by the increase in the hay crop merely. But were it attempted to make allowance for this, the results would not differ very widely from those recorded in the Tables. For, not only would by far the larger proportion of the nitrogen of the after-grass be returned to the land, but it would be only so much of the remainder as was due to increase by manure, that would have to be taken into the calculation. Nor are the data requisite for such a mode of estimation sufficiently established to render any such supposed correction at all desirable. It is, however, well to make this reservation in regard to the figures recorded in the Tables.

It may be interesting here to observe that, in experiments with wheat conducted over six years, 43 per cent., and in others with barley, also over six years, 42·5 per cent. of the nitrogen supplied in the manure was estimated to be recovered as increased yield. Against these amounts the average result obtained with the meadow-hay over seven years was, in parallel cases, 45·1, which, raised by the small amount due to the after-grass, as above explained, would show that the mixed herbage of meadow-land probably gathers up within the season of application a somewhat larger proportion of the nitrogen supplied as manure than either wheat or barley.

In our former report we directed attention to the probable explanations of the real or apparent loss of nitrogen here indicated; and we would refer the reader to a discussion of the subject in a paper "On the Sources of the Nitrogen of Vegetation; with special reference to the question whether plants assimilate free or uncombined nitrogen," in the 'Journal of the Chemical Society of London,' Ser. 2, Vol. 1, 1863.

Upon the whole, the evidence goes to show, that stable or farmyard-manure is a much more perfect restorer of the constituents removed in the hay-crop than those purchased or so-called artificial manures which, in a practical or economical point of view, can be advantageously employed. Farmyard-dung is, however, comparatively slow in its action. These characters point to the peculiar fitness of such manure for meadow-land mown for hay; and it was shown in our Report in the last number of the Journal, that the description of herbage developed by it was much more complex, and upon the whole superior in quality, to that developed by the more active artificial manures. On the other hand, provided the restoration of the potass and silica of the hay-crop be duly accomplished by means of farmyard-manure occasionally applied, its slowness of action may

be advantageously compensated by a judicious use of some of the more active artificial or purchased manures.

In the experiments which form the subject of this paper, the amount of farmyard-manure annually employed was 14 tons per acre, which would doubtless contain very much more of every constituent of the hay-crop than the produce yielded. Under these circumstances, although the superaddition of ammonia-salts considerably increased the crop, they gave a less result than under any of the other conditions of experiment. If the same amount of farmyard-manure, or even less of well-rotted dung, were employed once in four or five years, this would supply sufficient of most of the mineral constituents for a larger amount of increase than would be obtained in several years by its use alone; and, under such circumstances, the additional application of moderate quantities of the more rapidly active manures, such as Peruvian-guano, or ammonia-salts or nitrate of soda and superphosphate of lime, would not only serve to bring into more rapid use the constituents of the dung, but the increase of crop would be obtained without injury to the permanent condition of the land, and with little detriment to the character of the herbage developed.

Under some circumstances ammonia-salts, and under others nitrates, seem to be the more active in proportion to the nitrogen they contain. But, as the mixed herbage of grass-land includes plants of very different habits of growth, seeking their nutriment at very different ranges within the soil, and as the nitrogen of nitrate of soda becomes distributed much more rapidly than that of ammonia-salts, it is desirable to employ a mixture of these two manures. By this means the growth of a greater variety of plants is favoured, and very probably a greater amount of increase will be obtained within a given time for a given amount of nitrogen applied.

Assuming the dung to be employed in quantity sufficient for the due restoration of the alkalies, alkaline earths, and silica, it would, of course, at the same time supply a considerable amount of phosphoric acid also. But experience shows that, even when this is done, activity of growth is frequently considerably increased if direct phosphatic manures be also employed. The phosphoric acid may be advantageously and economically applied either in the form of Peruvian guano, which at the same time supplies a large quantity of ammonia or ammonia-yielding matter and a little potass also, or as superphosphate of lime.

EXPERIMENTS at ROTHAMSTED with DIFFERENT MANURES ON PERMANENT MEADOW LAND.

TABLE II.—SHOWING the QUANTITY of HAY to which the AFTER-GRASS (consumed by Sheep on the Land) is estimated to be equivalent; calculated on the assumption that each Sheep would eat Grass = 16 lbs. of Hay per Week.

Plot. Nos.	MANURES PER ACRE, PER ANNUM. (For detailed description, see pp. 304-5.)	After-grass estimated as Hay (per Acre, per Annum).				
		1859. Second and Third Crop.	1860. Second and Third Crop.	1861. Second and Third Crop.	1862. Second and Third Crop.	Average. Of 4 Years (1859-62). Of 7 Years (1856-62).

SERIES 1.—Without Direct Mineral Manure.						
1	Unmanured (duplicate plot)	lbs. 1112	lbs. 2112	lbs. 1718	lbs. 1598	lbs. 1549
2	Unmanured	883	2146	1664	1756	1454
4	Mean, or Standard Unmanured	886	2189	1645	1737	1470
5	200 lbs. each, Sulphate and Muriate Ammonia	904	2223	1644	1646	1459
6	200 lbs. each, Sulphate and Muriate Ammonia, and 3000 lbs. Sawdust	908	2223	1644	1646	1459
7	275 lbs. Nitrate of Soda	883	1507	1486	2304	1515
7	350 lbs. Nitrate of Soda	900	1507	1486	2304	1515

SERIES 2.—With Direct Mineral Manure.						
3a	Superphosphate of Lime	823	2112	1598	1863	1598
3b	Superphosphate of Lime, and 200 lbs. each, Sulphate and Muriate Ammonia	967	2323	1646	2157	1778
8	"Mixed Mineral Manure", and 200 lbs. Sawdust	1284	2378	1788	1901	1834
9	"Mixed Mineral Manure", and 200 lbs. each, Sulphate and Muriate Ammonia	1284	2378	1788	1901	1834
10	"Mixed Mineral Manure", and 200 lbs. each, Sulphate and Muriate Ammonia, and 3000 lbs. Sawdust	1284	2378	1788	1901	1834
11	"Mixed Mineral Manure", and 200 lbs. each, Sulphate and Muriate Ammonia, and 3000 lbs. Sawdust	1284	2378	1788	1901	1834
12	Wheat-Straw	1284	2378	1788	1901	1834
13	"Mixed Mineral Manure", and 400 lbs. each, Sulphate and Muriate Ammonia	1646	2434	1788	2735	2004
13a	"Mixed Mineral Manure" (including 200 lbs. each, Silicates Soda, and Lime), and 400 lbs. each	1646	2434	1788	2735	2004
13b	"Mixed Mineral Manure" (including 200 lbs. each, Silicates Soda, and Lime), and 400 lbs. each	1646	2434	1788	2735	2004
14	"Mixed Mineral Manure", and 275 lbs. Nitrate of Soda	823	1576	1701	2304	1601
15	"Mixed Mineral Manure", and 350 lbs. Nitrate of Soda	900	2010	1736	2304	1750

SERIES 3.—With Farmyard Manure.						
16	14 tons Farmyard Manure	1098	2438	1735	2395	1920
17	14 tons Farmyard Manure, and 100 lbs. each, Sulphate and Muriate Ammonia	1098	2438	1735	2395	1920

* With Sulphate of Potash excluded, and the amount of Sulphate of Soda increased, in 1862. † Only 200 lbs. each in 1859, 1860, and 1861. ‡ Average of 5 years only.

EXPERIMENTS at ROTHAMSTED with DIFFERENT MANURES ON PERMANENT MEADOW LAND.
TABLE III.—PERCENTAGES of DRY SUBSTANCE in the HAY (Means of Duplicate Determinations).

Plot, Nos.	MANURES PER ACRE, PER ANNUM. (For detailed description, see pp. 504-5.)	1859.				1860.		1861.		1862.		Average.
		Cut June 27; Carted July 5.	Cut July 7; Carted July 13.	Cut July 11; Carted July 18.	Cut June 29; Carted July 3.	Cut June 25; Carted July 4-8.	Cut June 25; Carted July 4-8.					
SERIES 1.—Without Direct Mineral Manure.												
1	Unmanured (duplicate plot)	88.7	82.9	85.3	78.5	88.9	84.0	83.5	83.9	84.0		
2	Unmanured	86.5	79.7	84.1	79.5	84.1	79.5	84.1	79.5	83.5		
4	Mean, or Standard Unmanured	87.5	81.3	84.7	79.0	83.1	83.8	83.1	83.1	83.8		
5	200 lbs. each, Sulphate and Muriate Ammonia	87.4	81.0	83.9	79.5	83.2	83.0	83.2	79.5	83.0		
6	200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Sawdust	85.0	79.3	84.7	78.8	84.7	82.5	82.7	78.8	82.5		
7	275 lbs. Nitrate of Soda	83.7	79.3	85.0	77.5	85.0	81.4	81.4	77.5	82.3		
	500 lbs. Nitrate of Soda											
	Mean	85.0	80.5	84.1	78.6	84.1	81.4	81.4	80.5	83.9		
SERIES 2.—With Direct Mineral Manure.												
34	Superphosphate of Lime	87.4	81.3	88.5	78.8	88.6	88.8	88.8	78.8	88.8		
35	Superphosphate of Lime, and 200 lbs. each, Sulphate and Muriate Ammonia	86.4	80.3	88.9	77.4	84.7	88.0	88.0	77.4	88.0		
8	Mixed Mineral Manure*, and 2000 lbs. Sawdust	87.7	79.9	84.0	79.3	84.0	83.7	83.7	79.3	83.7		
9	Mixed Mineral Manure*, and 200 lbs. each, Sulphate and Muriate Ammonia	86.9	81.3	83.5	79.3	84.0	83.7	83.7	79.3	83.7		
10	Mixed Mineral Manure*, and 200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Sawdust	88.9	81.3	85.7	78.3	83.7	81.5	81.5	78.3	83.1		
11	Mixed Mineral Manure*, 200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Sawdust	86.3	78.4	83.7	79.7	83.7	83.3	83.3	79.7	83.5		
12	Wheat-Straw	87.0	78.4									
13	Mixed Mineral Manure*, and 400 lbs. each, Sulphate and Muriate Ammonia	85.0	76.9	83.6	78.0	83.6	80.9	80.9	78.0	81.3		
13a	Mixed Mineral Manure*, (including 200 lbs. each, Silicates Soda, and Lime), and 400 lbs. each, Sulphate and Muriate Ammonia	84.4	78.6	84.5	79.4	84.5	81.7	81.7	79.4	82.7		
14	Mixed Mineral Manure*, and 275 lbs. Nitrate of Soda	86.0	80.3	84.7	79.4	84.7	83.4	83.4	79.4	83.5		
15	Mixed Mineral Manure*, and 500 lbs. Nitrate of Soda											
	Mean	86.9	79.7	84.0	78.7	84.0	83.1	83.1	78.7	83.5		
SERIES 3.—With Farmyard Manure.												
16	14 tons Farmyard Manure	86.3	82.7	84.6	77.9	84.6	83.4	83.4	77.9	83.0		
17	14 tons Farmyard Manure, and 100 lbs. each, Sulphate and Muriate Ammonia	87.3	81.3	84.3	79.4	84.3	83.4	83.4	79.4	83.4		
* With Sulphate of Potash excluded, and the amount of Sulphate of Soda increased, in 1862. † Only 200 lbs. each in 1859, 1860, and 1861. ‡ Average of 5 years only.												

* With Sulphate of Potash excluded, and the amount of Sulphate of Soda increased, in 1862. † Only 200 lbs. each in 1859, 1860, and 1861. ‡ Average of 5 years only.

EXPERIMENTS at ROTHAMSTED with DIFFERENT MANURES on PERMANENT MEADOW LAND.

TABLE IV.—PERCENTAGES of MINERAL MATTER (Ash) in the HAY (Means of Duplicate Determinations).

Plot, No.	MANURES PER ACRE, PER ANNUM (For detailed description, see pp. 304-5.)	Percentages in the Hay as taken from the Land.						Percentages in the Dry Substance of the Hay.					
		1899.			1861.			1860.			1861.		
		Cut June 27; July 7; July 13; July 3.	Cut June 27; July 7; July 13; July 3.	Average. Of 4 Years 1899-1902. (1899-02).	Cut June 27; July 7; July 13; July 3.	Cut June 27; July 7; July 13; July 3.	Average. Of 4 Years 1899-1902. (1899-02).	Cut June 27; July 7; July 13; July 3.	Cut June 27; July 7; July 13; July 3.	Average. Of 4 Years 1899-1902. (1899-02).	Cut June 27; July 7; July 13; July 3.	Cut June 27; July 7; July 13; July 3.	Average. Of 4 Years 1899-1902. (1899-02).

SERIES 1.—Without Direct Mineral Manure.

1	Unmanured	6.34	5.77	5.77	5.77	5.77	5.77	7.13	7.35	7.25	7.90	7.90	7.16
2	Unmanured (duplicate plot)	6.34	5.77	5.77	5.77	5.77	5.77	7.13	7.35	7.25	7.90	7.90	7.16
4	Mean, or Standard Unmanured	6.33	5.76	5.76	5.76	5.76	5.76	7.13	7.35	7.25	7.90	7.90	7.16
5	200 lbs. each, Sulphate and Murate Ammonia	5.46	5.33	5.33	5.33	5.33	5.33	5.94	6.33	6.33	7.35	7.35	7.12
6	200 lbs. Nitrate of Soda	5.46	5.33	5.33	5.33	5.33	5.33	5.94	6.33	6.33	7.35	7.35	7.12
7	500 lbs. Nitrate of Soda	5.94	6.06	6.06	6.06	6.06	6.06	6.98	7.64	6.71	8.28	7.40	7.17
	Mean.	5.84	5.74	5.74	5.74	5.74	5.74	6.81	7.14	6.51	7.60	7.01	6.96

SERIES 2.—With Direct Mineral Manure.

24	Superphosphate of Lime	6.98	6.58	6.58	6.58	6.58	6.58	7.98	8.28	7.90	8.11	8.00	..
25	Muriate Ammonia	6.98	6.58	6.58	6.58	6.58	6.58	7.98	8.28	7.90	8.11	8.00	..
8	Mixed Mineral Manure	7.16	6.98	6.98	6.98	6.98	6.98	8.17	8.66	8.41	8.67	8.23	8.05
9	Mixed Mineral Manure, and 200 lbs. Sawdust	7.06	6.90	6.90	6.90	6.90	6.90	8.14	8.66	8.41	8.67	8.07	8.10
10	Mixed Mineral Manure, and 200 lbs. each, Sulphate and Murate Ammonia	6.34	6.06	6.06	6.06	6.06	6.06	7.75	7.80	7.26	7.70	7.63	7.75
11	Mixed Mineral Manure, 200 lbs. each, Sulphate and Murate Ammonia, and 200 lbs. Sawdust	6.99	6.85	6.85	6.85	6.85	6.85	8.21	8.68	8.67	7.57	8.03	8.10
12	Mixed Mineral Manure, 200 lbs. each, Sulphate and Murate Ammonia, and 200 lbs. Cut Wheat-Straw	6.94	6.40	6.40	6.40	6.40	6.40	7.98	8.17	7.98	7.51	7.91	7.95
13a	Mixed Mineral Manure, and 400 lbs. each, Sulphate and Murate Ammonia	6.61	6.56	6.56	6.56	6.56	6.56	7.77	7.83	7.54	8.21	7.69	7.79
13b	Mixed Mineral Manure, (including 200 lbs. each, Sulphate and Murate Ammonia, and 400 lbs. each, Sulphate and Murate Ammonia)	..	..	..	..	..	..	..	..	..	8.36	..	..
14	Mixed Mineral Manure, and 275 lbs. Nitrate of Soda	6.65	6.85	6.85	6.85	6.85	6.85	7.98	7.98	7.67	8.73	8.25	8.06
15	Mixed Mineral Manure, and 500 lbs. Nitrate of Soda	6.35	6.04	6.04	6.04	6.04	6.04	7.53	7.53	7.30	8.31	7.60	7.61
	Mean	6.73	6.45	6.45	6.45	6.45	6.45	7.83	8.10	7.50	8.03	7.96	7.95

SERIES 3.—With Farnyard Manure.

16	14 tons Farnyard Manure	6.96	6.74	6.74	6.74	6.74	6.74	7.98	8.16	8.03	9.33	8.35	8.34
17	14 tons Farnyard Manure, and 100 lbs. each, Sulphate and Murate Ammonia	6.76	6.81	6.81	6.81	6.81	6.81	7.74	8.39	7.71	8.68	8.18	8.26

* With Sulphate of Potash excluded, and the amount of Sulphate of Soda increased, in 1899. † Only 300 lbs. each in 1899, 1890, and 1891. ‡ Average of 5 years only.

EXPERIMENTS at ROTHAMSTED with DIFFERENT MANURES on PERMANENT MEADOW LAND.
TABLE V.—PERCENTAGES of NITROGEN in the HAY (Means of Duplicate Determinations).

Plot, No.	MANURES PER ACRE, PER ANNUM (For detailed description, see pp. 504-5.)	Percentages in the Hay as taken from the Land.					Percentages in the Dry Substance of the Hay.				
		1859.		1860.		Average.	1859.		1860.		Average.
		Cut June 27; carted July 5.	Cut June 29; carted July 13.	Cut June 29; carted July 5.	Cut June 29; carted July 13.		Cut June 27; carted July 5.	Cut June 29; carted July 13.	Cut June 29; carted July 5.	Cut June 29; carted July 13.	
1	Unmanured (duplicate plot)	1.50	1.31	1.31	1.19	1.34	1.39	1.64	1.38	1.56	1.50
2	Unmanured (duplicate plot)	1.50	1.36	1.31	1.28	1.37	1.44	1.74	1.53	1.57	1.73
3	Mean of Standard Unmanured	1.50	1.41	1.30	1.22	1.36	1.41	1.72	1.33	1.45	1.63
4	200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Sawdust	1.74	1.84	1.90	1.71	1.75	1.68	2.25	2.06	2.17	2.13
5	200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Sawdust	1.68	1.70	1.67	1.47	1.63	1.60	2.10	2.01	1.87	1.98
6	275 lbs. Nitrate of Soda	1.58	1.58	1.43	1.30	1.43	1.42	1.74	1.67	1.66	1.73
7	550 lbs. Nitrate of Soda	1.58	1.58	1.43	1.43	1.53	1.57	1.80	1.86	1.87	1.91
	Mean	1.68	1.57	1.54	1.43	1.54	1.55	1.94	1.68	1.68	1.87

SERIES 1.—Without Direct Mineral Manure.											
22	Superphosphate of Lime	1.59	1.37	1.39	1.23	1.39	1.39	1.61	1.68	1.54	1.67
23	Superphosphate of Lime, and 200 lbs. each, Sulphate and Muriate Ammonia	1.41	1.43	1.49	1.38	1.43	1.43	1.79	1.79	1.78	1.74
8	"Mixed Mineral Manure"	1.37	1.49	1.29	1.31	1.42	1.46	1.73	1.51	1.67	1.71
9	"Mixed Mineral Manure"*, and 200 lbs. Sawdust	1.56	1.56	1.54	1.27	1.44	1.49	1.82	1.59	1.59	1.73
10	"Mixed Mineral Manure", and 200 lbs. each, Sulphate and Muriate Ammonia	1.18	1.21	1.28	1.15	1.23	1.23	1.43	1.65	1.45	1.51
11	"Mixed Mineral Manure"*, 200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Sawdust	1.12	1.20	1.19	1.16	1.17	1.17	1.33	1.52	1.48	1.44
12	"Mixed Mineral Manure", 200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Cut Wheat-Straw	1.23	1.23	1.23	1.09	1.21	1.23	1.40	1.55	1.56	1.56
13a	"Mixed Mineral Manure", and 400 lbs. each, Sulphate and Muriate Ammonia	1.29	1.19	1.23	1.41	1.28	1.43	1.53	1.55	1.47	1.59
13b	"Mixed Mineral Manure" (including 200 lbs. each, Sulphate Soda, and Lime), and 400 lbs. each, Sulphate and Muriate Ammonia	..	..	..	1.41	..	..	..	..	1.79	..
14	"Mixed Mineral Manure", and 275 lbs. Nitrate of Soda	1.42	1.30	1.28	1.13	1.23	1.32	1.69	1.65	1.50	1.67
15	"Mixed Mineral Manure", and 550 lbs. Nitrate of Soda	1.21	1.17	1.18	1.13	1.17	1.20	1.43	1.45	1.39	1.43
	Mean	1.26	1.31	1.31	1.24	1.30	1.32	1.59	1.66	1.56	1.61

SERIES 3.—With Farnyard Manure.											
16	14 tons Farnyard Manure	1.20	1.19	1.26	1.10	1.19	1.25	1.36	1.44	1.46	1.49
17	14 tons Farnyard Manure, and 100 lbs. each, Sulphate and Muriate Ammonia	1.17	1.20	1.23	1.13	1.18	1.24	1.34	1.48	1.48	1.50

* With Sulphate of Potash excluded, and the amount of Sulphate of Soda increased, in 1860.
† Only 500 lbs. each in 1859, 1860, and 1861.
‡ Average of 5 years only.

EXPERIMENTS at ROTHAMSTED with DIFFERENT MANURES on PERMANENT MEADOW LAND.

TABLE VI.—PRODUCE OF TOTAL DRY SUBSTANCE per Acre; lbs.

Plot Nos.	MANURES PER ACRE, PER ANNUM. (For detailed description, see pp. 404-5.)	Annual Produce.				Average Annual Produce per Acre by Manure.	
		1869.		1861.		Average.	
		1869.	1860.	1861.	1862.	Of 4 Years (1859-62).	Of 7 Years (1854-62).
1	Unmanured (duplicate plot):	lbs. 2239	lbs. 2286	lbs. 2494	lbs. 2536	lbs. 2504	lbs. . .
2	Unmanured (duplicate plot):	2238	2297	2777	2728	2504	. . .
3	Mean, or Standard Unmanured	2238	2297	2777	2728	2504	. . .
4	200 lbs. each, Sulphate and Muriate Ammonia	2577	2684	2611	2538	2584	724
5	200 lbs. each, Sulphate and Muriate Ammonia, and 200 lbs. Sawdust	2114	2404	2264	2404	2304	674
6	275 lbs. Nitrate of Soda.	2444	2494	2464	2504	2464	684
7	500 lbs. Nitrate of Soda.	2444	2494	2464	2504	2464	774
						2304	1084
SERIES 1.—Without Direct Mineral Manure.							
8	Superphosphate of Lime	2474	2504	2641	2568	2614	184
9	"Superphosphate of Lime," and 200 lbs. each, Sulphate and Muriate Ammonia	4317	2544	4184	2584	4004	1814
10	"Mixed Mineral Manure,"* and 200 lbs. Sawdust.	2524	2574	2674	2594	2594	1014
11	"Mixed Mineral Manure,"* and 200 lbs. each, Sulphate and Muriate Ammonia	5144	4264	4374	5074	4584	2644
12	"Mixed Mineral Manure,"* 200 lbs. each, Sulphate and Muriate Ammonia, and 200 lbs. Sawdust	486	4224	4364	4904	456	274
13	"One Wheat-Straw," and 400 lbs. each, Sulphate and Muriate Ammonia	6064	4214	4494	4904	4514	277
14	"Mixed Mineral Manure," (including 200 lbs. each, Silicates Soda, and Lime), and 400 lbs. each, Sulphate and Muriate Ammonia	6064	4414	4604	5044	4684	2894
15	"Mixed Mineral Manure," and 275 lbs. Nitrate of Soda	4184	2784	467	5584	. . .	1767
16	"Mixed Mineral Manure," and 500 lbs. Nitrate of Soda	513	467	4684	4384	4784	2484
SERIES 2.—With Farnyard Manure.							
16	14 tons Farnyard Manure	4044	487	4275	3949	4124	1614
17	14 tons Farnyard Manure, and 100 lbs. each Sulphate and Muriate Ammonia :	4678	4504	467	4334	4574	1784

* Only 200 lbs. each in 1859, 1860, and 1861. † Average of 5 years only.

EXPERIMENTS at ROTHAMSTED with DIFFERENT MANURES on PERMANENT MEADOW LAND.

TABLE VII.—PRODUCE OF TOTAL MINERAL MATTER (Ash) per Acre; lbs.

Plot No.	MANURES PER ACRE, PER ANNUM. (For detailed description, see pp. 504-5.)	Annual Produce.				Average Annual Increase by Manure.		
		1859.	1860.	1861.	1862.	Average.		
						Of 4 Years (1859-62).	Of 7 Years (1856-62).	Of 7 Years (1856-62).

SERIES 1.—Without Direct Mineral Manure.

		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
1	Unmanured (duplicate plot)	163.5	163.1	168.3	167.6	171.2	163.4	163.4
2	Unmanured (duplicate plot)	163.5	163.1	168.3	167.6	171.2	163.4	163.4
4	300 lbs. each, Sulphate and Muriate Ammonia	161.9	169.6	178.5	167.3	174.3	167.5	15.9
5	300 lbs. each, Sulphate and Muriate Ammonia	199.7	156.8	197.6	206.6	190.2	204.5	37.0
6	275 lbs. Nitrate of Soda	203.9	156.3	197.7	229.7	186.3	207.7	22.6
7	550 lbs. Nitrate of Soda	213.1	239.2	232.9	216.0	250.8	224.52	67.02
		240.4	267.2	253.9	265.2	255.9	243.12	81.6

SERIES 2.—With Direct Mineral Manure.

		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
84	Superphosphate of Lime	184.9	213.2	221.7	203.0	209.2	207.3	84.9
85	Superphosphate of Lime, and 200 lbs. Sulphate and Muriate Ammonia	313.7	301.8	275.4	263.8	266.2	261.0	111.9
86	"Mixed Mineral Manure"	244.6	273.0	261.8	261.0	274.9	261.0	107.7
9	"Mixed Mineral Manure," and 200 lbs. Sawdust	239.9	269.0	263.8	259.9	277.1	267.3	107.7
10	"Mixed Mineral Manure," and 200 lbs. each, Sulphate and Muriate Ammonia	266.4	266.3	263.0	259.2	267.8	267.4	236.8
11	"Mixed Mineral Manure," 200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Nitrate of Soda	469.2	267.2	413.2	265.6	386.8	413.0	244.5
12	"Mixed Mineral Manure," 200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Nitrate of Soda	464.1	266.6	433.9	266.4	413.8	267.3	237.3
132	"Mixed Mineral Manure," and 400 lbs. each, Sulphate and Muriate Ammonia	473.5	319.4	422.7	454.9	417.4	435.6	263.1
136	"Mixed Mineral Manure," (including 200 lbs. each, Silicate of Soda, and 400 lbs. each, Sulphate and Muriate Ammonia)	473.5	319.4	422.7	454.9	417.4	435.6	263.1
14	"Mixed Mineral Manure," and 275 lbs. Nitrate of Soda	266.5	269.5	267.3	269.1	263.9	259.32	161.62
15	"Mixed Mineral Manure," and 550 lbs. Nitrate of Soda	275.9	277.4	267.3	269.1	263.9	259.32	161.62

SERIES 3.—With Farmyard Manure.

		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
16	14 tons Farmyard Manure	318.5	361.2	342.7	366.0	345.1	328.7	170.8
17	14 tons Farmyard Manure, and 100 lbs. each, Sulphate and Muriate Ammonia	331.9	338.6	346.0	346.7	370.8	373.2	196.5

• With Sulphate of Potash excluded, and the amount of Sulphate of Soda increased, in 1862.

† Only 300 lbs. each in 1859, 1860, and 1861.

‡ Average of 5 years only.

EXPERIMENTS at ROTHAMSTED with DIFFERENT MANURES ON PERMANENT MEADOW LAND.
TABLE VIII.—PRODUCE OF NITROGEN per Acre; 1 lb.

Plot, No.	MANURES PER ACRE, PER ANNUM. (For detailed description, see pp. 504-5.)	Annual Produce.					Average Annual Increase by Manure.	
		1859.	1860.	1861.	1862.	Average.		
						Of 4 Years (1859-62).	Of 7 Years (1856-62).	
SERIES 1.—Without Direct Mineral Manure.								
1	Unmanured (duplicate plot).	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
2	Unmanured (duplicate plot).	38.1	37.5	37.3	37.3	37.6	37.6	..
		38.6	41.8	46.9	48.3	48.3	48.3	..
4	200 lbs. each, Sulphate and Muriate Ammonia.	38.4	39.7	38.9	38.9	39.9	39.9	25.4
5	Mean, or Standard Unmanured	38.4	39.7	41.6	38.9	39.9	38.9	21.0
6	200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Sawdust	63.4	64.1	65.9	65.9	60.9	60.9	18.9
7	275 lbs. Nitrate of Soda.	54.7	54.7	57.8	57.8	56.8	55.32	15.42
	350 lbs. Nitrate of Soda.	65.4	66.2	70.3	68.3	65.3	64.42	24.32
SERIES 2.—With Direct Mineral Manure.								
2a	Superphosphate of Lime	45.0	45.5	47.3	49.9	49.9	49.9	..
2b	Superphosphate of Lime, and 200 lbs. each, Sulphate and Muriate Ammonia.	70.4	69.5	74.0	68.6	68.6	68.6	15.9
3	"Mixed Mineral Manure," and 200 lbs. each, Sulphate and Muriate Ammonia.	53.6	53.6	57.9	59.0	59.3	59.3	20.5
9	"Mixed Mineral Manure," and 200 lbs. each, Sulphate and Muriate Ammonia.	54.3	57.9	57.5	59.3	60.4	60.4	20.5
10	"Mixed Mineral Manure," and 200 lbs. each, Sulphate and Muriate Ammonia.	73.1	68.1	67.3	73.6	70.5	70.5	38.0
11	"Mixed Mineral Manure," 200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Sawdust	65.6	64.3	76.5	71.7	69.5	69.6	33.0
13	"Mixed Mineral Manure," 200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Cut Wheat-Straw	68.1	70.2	67.1	77.0	73.1	73.1	39.3
13a	"Mixed Mineral Manure," and 400 lbs. each, Sulphate and Muriate Ammonia	62.3	66.4	62.5	100.3	65.8	65.9	18.4
13b	"Mixed Mineral Manure," (including 200 lbs. each, Silicates Soda, and Lime), and 400 lbs. each, Sulphate and Muriate Ammonia	..	..	..	100.4	..	..	..
14	"Mixed Mineral Manure," and 275 lbs. Nitrate of Soda	70.4	68.6	70.6	59.5	65.3	65.32	25.42
15	"Mixed Mineral Manure," and 550 lbs. Nitrate of Soda	73.5	65.4	69.5	66.3	66.3	66.32	33.62
SERIES 3.—With Farmyard Manure.								
16	14 tons Farmyard Manure	55.0	63.0	63.7	59.7	59.1	59.5	18.6
17	14 tons Farmyard Manure, and 100 lbs. each, Sulphate and Muriate Ammonia	62.7	68.4	65.4	63.2	64.7	61.5	27.6

* With Sulphate of Potash excluded, and the amount of Sulphate of Soda increased, in 1862.
† Only 200 lbs. each in 1860, 1860, and 1861.
‡ Average of 5 years only.

• With Sulphate of Potash excluded, and the amount of Sulphate of Soda increased, in 1862.

† Only 300 lbs. each in 1859, 1860, and 1861.

‡ Average of 5 years only.

EXPERIMENTS at ROTHAMSTED with DIFFERENT MANURES on PERMANENT MEADOW LAND.

TABLE IX.—INCREASED YIELD OF NITROGEN PER ACRE when a known Quantity was supplied in MANURE; lbs.

Plot, Nos.	MANURES PER ACRE, PER ANNUM. (For detailed description, see pp. 504-5.)	Increase over the yield without Manure.					Increase over the yield by the "Mixed Mineral Manure."				
		1859. 1860. 1861. 1862.			Average		1859. 1860. 1861. 1862.			Average	
		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	Of 4 Years (1859-62.)
4	200 lbs. each, Sulphate and Muriate Ammonia	25.0	14.4	25.3	23.2	23.4	..	..	..	..	..
5	200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Sawdust	23.3	11.0	28.0	21.0	21.1	..	..	..	..	..
6	275 lbs. Nitrate of Soda	18.3	14.8	18.2	16.9	15.3	..	..	..	..	..
7	200 lbs. Nitrate of Soda	27.1	20.5	30.4	25.4	24.5	..	..	..	..	..

SERIES 1.—Without Direct Mineral Manure.

Plot, Nos.	MANURES PER ACRE, PER ANNUM. (For detailed description, see pp. 504-5.)	Increase over the yield without Manure.					Increase over the yield by the "Mixed Mineral Manure."				
		1859. 1860. 1861. 1862.			Average		1859. 1860. 1861. 1862.			Average	
		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	Of 4 Years (1859-62.)
8	200 lbs. each, Sulphate and Muriate Ammonia	25.0	14.4	25.3	23.2	23.4	..	..	..	..	..
9	200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Sawdust	23.3	11.0	28.0	21.0	21.1	..	..	..	..	..
10	275 lbs. Nitrate of Soda	18.3	14.8	18.2	16.9	15.3	..	..	..	..	..
11	200 lbs. Nitrate of Soda	27.1	20.5	30.4	25.4	24.5	..	..	..	..	..

SERIES 2.—With Direct Mineral Manure.

Plot, Nos.	MANURES PER ACRE, PER ANNUM. (For detailed description, see pp. 504-5.)	Increase over the yield without Manure.					Increase over the yield by the "Mixed Mineral Manure."				
		1859. 1860. 1861. 1862.			Average		1859. 1860. 1861. 1862.			Average	
		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	Of 4 Years (1859-62.)
12	Superphosphate of Lime, and 200 lbs. each, Sulphate and Muriate Ammonia	28.1	24.1	24.0	28.8	..	16.8	10.0	16.1	7.6	12.6
13	" Mixed Mineral Manure,"* and 200 lbs. each, Sulphate and Muriate Ammonia	24.8	28.4	23.0	25.6	28.1	19.5	9.6	29.3	15.6	21.1
14	" Mixed Mineral Manure,"* 200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Sawdust	27.2	24.7	30.1	29.7	23.1	11.9	5.8	18.6	13.7	16.1
15	" Mixed Mineral Manure,"* 200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Cut Wheat-Straw	46.7	30.5	25.5	37.1	39.2	31.5	11.7	27.8	9.1	20.0
16	" Mixed Mineral Manure,"* (including 200 lbs. each, Sulphate and Muriate Ammonia), and 400 lbs. each, Sulphate and Muriate Ammonia	23.9	28.7	23.6	25.4	28.4	28.6	9.9	24.6	23.3	21.5
17	" Mixed Mineral Manure,"* and 275 lbs. Nitrate of Soda	23.0	22.9	16.9	20.6	23.4	..	..	..	..	..
18	" Mixed Mineral Manure,"* and 200 lbs. Nitrate of Soda	25.1	20.7	22.0	22.6	25.4	16.8	4.1	12.7	0.9	8.5
19	" Mixed Mineral Manure,"* and 200 lbs. Nitrate of Soda	25.1	20.7	22.0	22.6	25.4	19.9	6.9	11.6	6.6	11.3

SERIES 3.—With Farmyard Manure.†

Plot, Nos.	MANURES PER ACRE, PER ANNUM. (For detailed description, see pp. 504-5.)	Increase over the yield without Manure.					Increase over the yield by the "Mixed Mineral Manure."				
		1859. 1860. 1861. 1862.			Average		1859. 1860. 1861. 1862.			Average	
		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	Of 4 Years (1859-62.)
20	14 tons Farmyard Manure, and 100 lbs. each, Sulphate and Muriate Ammonia	7.7	6.3	1.8	5.7	9.0	..	..	..	..	..

* With Sulphate of Potash excluded, and the amount of Sulphate of Soda increased, in 1862.

† Only 200 lbs. each in 1859, 1860, and 1861.

‡ The increase is here taken over the yield by Farmyard Manure alone.

§ Average of 5 years only.

EXPERIMENTS at ROTHAMSTED with DIFFERENT MANURES on PERMANENT MEADOW LAND.
TABLE X.—NITROGEN recovered, and not recovered, as increased yield of it, for 100 supplied in MANURE.

TABLE A.—NITROGEN RECOVERED, AND NOT RECOVERED, AS INCREASED YIELD OF WHEAT, FOR 2000 IMPROVED ACRES													
Plot No.	MANURES PER ACRE, PER ANNUM. (For detailed description, see pp. 504-5.)	Increase taken over the field without Manure.					Increase taken over the yield by the "Mixed Mineral Manure."						
		Per Cent. of supplied Nitrogen recovered as Increase.			Average per Cent. of supplied Nitrogen not recovered as Increase.			Per Cent. of supplied Nitrogen recovered as Increase.			Average per Cent. of supplied Nitrogen not recovered as Increase.		
		Average			Of			Average			Of		
		1859			4 Years (1859-63).			1859			4 Years (1859-63).		
		1860	1861	1862	1859	1860	1861	1862	1859	1860	1861	1862	1859
4	200 lbs. each, Sulphate and Murate Ammonia	30.5	17.6	30.7	29.6	27.1	27.4	72.9	72.6	..	..	..	..
5	200 lbs. each, Sulphate & Murate Ammonia, and 2000 lbs. Sawdust	26.8	19.7	30.1	27.5	24.4	24.4	75.7	75.6	..	..	..	..
6	275 lbs. Nitrate of Soda	44.6	36.1	44.4	39.5	41.3	37.7	58.8	62.3	..	..	..	..
7	500 lbs. Nitrate of Soda	33.1	32.3	37.1	31.5	31.0	29.9	69.0	70.1	..	..	..	..
	Mean	33.8	24.7	33.6	29.5	30.9	29.9	69.1	70.1	..	..	..	..
SERIES 2.—With Direct Mineral Manure.													
20	Superphosphate of Lime, and 200 lbs. each, Sulphate and Murate Ammonia	39.1	35.1	41.6	29.3	26.3	..	63.7	..	20.5	13.2	19.6	9.3
10	"Mixed Mineral Manure," and 200 lbs. each, Sulphate and Murate Ammonia	43.4	34.6	57.6	39.0	43.4	46.5	54.6	53.5	22.8	11.7	35.7	19.0
11	"Mixed Mineral Manure," and 200 lbs. each, Sulphate and Murate Ammonia, and 2000 lbs. Sawdust	31.5	28.6	42.3	34.8	34.3	38.2	65.7	61.8	13.8	6.7	31.5	15.8
12	"Mixed Mineral Manure," and 200 lbs. each, Sulphate and Murate Ammonia, and 2000 lbs. Sawdust	49.4	32.2	46.4	27.0	29.2	41.4	60.8	56.6	32.3	13.4	29.4	9.6
13a	"Mixed Mineral Manure," and 400 lbs. each, Sulphate and Murate Ammonia	65.7	35.0	53.0	35.7	47.1	46.5	53.9	53.5	47.1	13.1	30.0	25.7
13b	"Mixed Mineral Manure" (including 200 lbs. each, Silicates of Soda, and Lime, and 400 lbs. each, Sulphate and Murate Ammonia)	..	..	..	35.9	..	..	..	..	..	..	..	..
14	"Mixed Mineral Manure," and 275 lbs. Nitrate of Soda	78.1	55.9	74.6	41.2	62.4	61.9	37.6	38.1	41.0	10.0	31.0	1.2
15	"Mixed Mineral Manure," and 500 lbs. Nitrate of Soda	42.8	31.3	36.1	28.1	34.6	36.1	63.4	63.2	24.3	8.4	14.1	8.0
	Mean	49.9	36.1	50.4	33.9	43.5	45.1	57.5	54.9	29.1	10.5	25.9	14.3
SERIES 3.—With Farmyard Manure.†													
17	14 tons Farmyard Manure, and 100 lbs. each, Sulphate and Murate Ammonia	18.8	15.9	4.4	16.1	13.6	21.9	66.2	78.1	..	..	..	..

† Only 200 lbs. each in 1859, 1860, and 1861.
‡ Average of 5 years only.
§ The increase is here taken over the yield by Farmyard Manure alone.

MISCELLANEOUS COMMUNICATIONS AND NOTICES.

1.—*Burning of Clay Land.* By C. RANDELL.

To H. S. THOMPSON, Esq., M.P.

DEAR SIR,

Chadbury near Evesham,
May 26th, 1863.

You ask me for any information I may have to give on the subject of burning clay and the mode of effecting that operation, in continuation of a letter which was inserted in our Society's Journal some years since, and you inquire especially as to my experience of the results hitherto obtained.

The duration of the beneficial effect of land-burning, that is, of burning the surface of clay soils, is very remarkable. I can point to several fields which were burned twenty years since, in which the improvement thereby effected still continues; and more particularly to one remarkable instance, where, in a field of 29 acres of very poor land, 12 acres were well burned, the remaining 17 acres, owing to less favourable weather, not so well. It is a steep hill-side, and for that reason has never had a cart-load of farmyard manure in the memory of man. Wheat has been grown every alternate year since the burning, the average produce of the whole field being not less than $4\frac{1}{2}$ quarters per acre. The intermediate crops have been either vetches or seeds fed off by sheep, the condition of the land being maintained by oilcake given to the sheep while consuming those crops, and by guano applied to the wheat at the time of sowing. The whole field has been treated alike since the burning; but every crop has testified to the more efficient way in which that operation was effected upon the 12 acres. This field shows both the permanence of the effect of this process, and the comparative advantages dependent on more or less skilful management.

Twenty-two years' experience of the effects of burning clay-land have confirmed my first impression of the benefit to be derived from it; and I may say with confidence, that, on such soils, apart from draining, I know of nothing by which so much good can be effected; and there is nothing which I would so strongly recommend a new tenant to adopt on entering upon a farm of this description, more especially if, as is often the case, he finds

his farm a foul one. Couch-grass is thus very effectually dealt with; and the more of it there is, the better will be the ashes, and the more satisfactory in every way the result of the operation.

I have nothing to add to what I before said as to the mode of proceeding, except that I prefer faggots to coal for land-burning, not only as being more economical, but because the soil is not burned so hard as is frequently the case where coal is used. In burning large heaps coal is essential; but it is well to let the burner provide it himself. He will use less, which is not only a saving of cost, but of more importance still as preventing the soil from being over-burned. He will make a ton of coal serve for 50 cubic yards; whereas otherwise it is not unusual to consume double that quantity.

After a field has been once moderately well burned, very little good appears to result from repeating the work; therefore my operations in this way are now almost entirely confined to burning large heaps, to be drawn into the yards and sheds wherein a large portion of the roots are consumed by sheep. They there absorb the urine, and are mixed with the dung made in the yards; the portion under cover is mixed with artificial manure, and drilled with the root-crops.

And this leads me to the consideration of a subject affected to a considerable extent by this burning question, viz., the additional capability of carrying a flock of sheep which clay-land acquires by the change of texture brought about by this process. I do not mean that clay-land can by this, or by any means, be made to produce food for sheep as beneficially or as certainly as that which is by nature turnip-land; but its capabilities in this respect may be enlarged, which is a matter of some importance at a time when the price of wool and mutton is relatively much higher than that of wheat (the more natural product of strong land) is, or is likely to be, whilst importations pour in from every quarter. Not that I would displace any portion of the wheat-crop by the substitution of fodder-crops for sheep; one-half of the arable portion of a clay-farm should always grow wheat. It is the mainstay of the occupiers of such soil; and whatever may be the price, it must be grown; and it is not only for the production of mutton and wool, but as a means of increasing the wheat-crop, that the increase of the sheep-stock becomes so important.

Under any circumstances, whether recourse is had to burning or not, I hold that there is no preparation for a wheat-crop upon any land so unprofitable as a bare fallow; and that if half of the arable portion of a clay-farm be, as I recommend, under wheat, the other half, with the exception of a portion manured for

beans, must be producing food for sheep. It is in facilitating the increased growth of this food for sheep that the burning of clay-soil adds so materially to the land's capability of producing wool and mutton, and consequently wheat.

I am strongly tempted by the result of six years' experience of the value of steam-cultivation in working out the system of cropping clay-land, which is intended to be most productive of these rent-paying commodities, to say a few words upon the subject; but as it has only facilitated, not changed, the system, and as those who are employing steam in the cultivation of the soil are not the men whose attention need be called to the advantages of growing green crops, I will withstand the temptation, and rather hope that my suggestions may receive consideration from those who occupy farms not of sufficient extent to justify the heavy outlay at present involved in the adoption of steam-cultivation.

The question of details as to the mode of carrying out this system of cropping when the land has been burned must still depend in some degree upon the nature of the farm. Few clay-land farms are, and none should be, without some portion of grass-land, on which to winter the breeding ewes, summer some beasts, and provide hay to assist in making the straw into manure; if they have the additional advantage of including some light land, no difficulty will exist in making the clay-land share equally with this light land the production of food for sheep, and the conversion by them of the larger portion of the straw into manure.

Assuming, then, that a farm consists of 20 acres pasture, 40 acres light or medium land, and 160 clay-land, and that 100 breeding ewes are kept, and their produce reared and fattened, there will then be annually—

	Acres.						
Wheat	100 ..
Clover—mown	20
Mixed seeds—grazed	20
Beans	10
Fallow crops	50

viz., 10 acres upon light land, of which 5 acres are to be Italian ryegrass, succeeded by swedes; 5 acres vetches, followed by turnips, both having been manured after harvest, not only to force early and abundant crops of food for the ewes and lambs, but also to save time, by having the land ready manured for swedes and turnips. The Italian rye-grass upon this light land, forced on by the manure applied after harvest, will be fed off by the middle of May. The roots should then be worked to the surface by Coleman's cultivator, by harrowing, rolling, and again harrow-

ing, then buried by one deep ploughing, and the land planted with swedes before the middle of June. The fallow crops upon 40 acres of clay-land will be,—mangolds, 12 acres; cabbages (of two varieties, to be planted in October), 8 acres; and vetches, 20 acres.

The green crops will be reversed every four years. Thus, where red clover was grown in 1860, there would be mixed seeds and beans in 1864; where ryegrass and swedes in 1860, vetches and turnips in 1864; and where mangolds and cabbages in 1860, vetches in 1864. It should also be borne in mind that on the clay-land, clover should be the next green crop after the mangold and cabbages; mixed seeds after the vetches.

The breeding ewes must be kept as long as possible upon the seeds; and while they are eating down those upon the clay to prepare the way for the plough, those on the lightest land—that which may be planted as soon as ploughed—must be saved. Upon this, when the clay-land seeds are finished, the ewes must be fed, with the addition of some chaff, if necessary, and so kept off the grass until the end of November, by which time all the land after seeds should be sown with wheat. The ewes then go into the strawyard, to be kept upon a mixture of hay and wheat-chaff, with malt-dust. They should be turned out four or five hours every day upon a fresh portion of the grass-land, a very small one; but the hurdles must be moved every day, and the allowance of grass increased, and the dry food improved, by the addition of oats or oilcake, as the yearning time approaches. After lambing, they go to the Italian ryegrass, of which they must have a fresh portion every day; for be it remembered that all the green food is supposed to be hurdled off; not only because it is economised thereby, but because the sheep will do better, and the land will be more equally manured than by giving the whole field at once. If all this Italian ryegrass is eaten before it is necessary that the land should be prepared for swedes, it will still be useful to remove the sheep to that field at night from off the other seeds, where their feet in the frosty mornings would be destructive. I need not point out how, with the provision of food for the summer months above indicated, the flock may be maintained—this, I hope, is sufficiently obvious; they are to be kept upon the land until the cabbages, turnips, and swedes are eaten, and then go into yards. The wether and draft-ewe lambs (tegs, as they are here called; hogs, in other counties) will then be fattened upon mangolds, with a liberal allowance of clover-chaff and malt-dust, and $\frac{1}{2}$ lb. oilcake, daily; the ewe-lambs intended to be kept for stock, will have mangolds, with a mixture of clover and wheat-chaff. Both will do better with

10 lbs. of roots each per day, from December to the end of February, than they would do with an unlimited quantity, provided they have as much dry food as they will eat. After February the allowance of mangolds should be increased, if the store will allow of this; and by the end of March the fattening tegs will be fit to go, shorn, to the butcher. If they can be kept a month longer so much the better. I have thus been supposing the case of a clay-land farm which is assisted by a small portion of a lighter character. Where there is only clay there will often be greater difficulty; and it may be necessary sometimes to sell off all or a portion of the lambs before September, instead of wintering them. In that case, as the whole of the straw cannot properly be made into manure, it is better that part should be sold off, the money arising from such sale being expended, half in guano and half in oilcake; the former to be applied to the wheat crop, the latter given to the ewes and lambs upon the seeds and vetches. I have conclusive proof in the field I named at the commencement of this letter, that farmyard manure is not essential to the fertility of clay-land, but that after draining and burning, the poorest of it may be maintained in productive condition, and grow wheat every other year by the aid of sheep, oilcake, and guano.

Believe me, dear Sir, faithfully yours,

C. RANDELL.

2.—*Portable Fencing for Sheep.* By THOMAS BOWICK.

FORFARSHIRE SYSTEM.

IN the vale of Strathmore it is not so customary as with us in Warwickshire for every farmer to keep a flock of his own, all the year round. There are several reasons for this. Dry stone walls, although a sufficient fence for horses or cattle, do not form a safe enclosure for the Blackfaced sheep, which is the prevailing breed. Hedges are not abundant, and, from the increasing scarcity of larch-trees, "paling" is a very costly article. Again, the great range of the Grampians—well styled the Alps of Scotland—stretching from Dumbarton on the west coast, to Stonehaven on the German Ocean, is a breeding district which furnishes many thousands of sheep; but the Highland glens, fertile as they often are, and abounding in the richest natural grasses, do not afford enough keep to sustain their flocks more than eight or nine months of the year. Hence the flock-master requires to look out for winter grazing in the low country, and

the lowland farmer, who may have no flock of his own, finds his advantage in providing such accommodation. The sheep thus sent out probably range over the old lea pastures or adjacent moors during the day, and at night are folded on any convenient spot which requires to be so manured. The use of nets as a portable fence, easily set up and readily removable, is almost essential to this system of management.

Again, an annual draft of the two or three-year-old wedders is disposed of in autumn to the lowland graziers or dealers, to be fattened upon turnips, and then sent either to the local markets or to the larger centres of consumption—Edinburgh, Glasgow, or Newcastle. A flock of about three hundred and fifty sheep is placed for the season under the care of one shepherd, who is expected to attend and feed them, set the nets, shift the flock from field to field,—or farm to farm, when needful,—to stock up the bottoms of the turnips, &c. &c.

Hence arises the desirability of having a really portable temporary fence, suitable for distant removals, and not very costly in the original outlay.

The Rev. Mr. Headrick, a well known local writer, remarks, in his Survey of Forfarshire, that the feeding of sheep on turnips, by means of nets, had then (1813) been recently introduced. Since that time the practice has extended, but has not greatly varied in its nature. Let me briefly describe it from the recollection of youthful days. This I can the more readily do, because that period was spent with a farming friend who fattened sheep extensively in the winter, and had also a breeding flock of three or four hundred ewes. As he approved of young men being actively employed, I was sent off for a couple of winters, when aged sixteen and seventeen respectively, in charge of a lot of more than three hundred. This phase of life, with its wanderings from farm to farm as the exigencies of food-supplies demanded, was a pleasant one—having plenty of variety, a few hardships, but a larger amount of enjoyment, and abundance of time for reading or other occupation. If you are going with a grazing lot of sheep—hoggets or ewes—little tackling is required, just sufficient for folding room over night, and if you give them about half an acre of fresh ground every few nights, from two to three hundred yards of netting will suffice; but if out with fattening sheep for the season, then a thousand yards or so will be required.

The material is either hemp or cotton—the latter article having been introduced, to a limited extent, during the past few years; but the rate for which it is at present sold may justly be regarded as prohibitive. Mr. Welsh, a large flockmaster in

the Mearns, thus writes to me :—"If cotton could be again got at the price it was some years ago, I should prefer it, as the nets made of it are considerably lighter, and consequently more manageable. Neither are they very easily broken." The length of each net, when set, may average fifty yards; though this of course varies a few yards according to the state of weather and the skill of the hand who sets them.

In weight, an untarred hemp net, with a pair of ropes running the full length of the net, and a dozen yards to spare, will be about a quarter of a hundredweight. A man can thus carry with comfort at least a couple of hundred yards of the needful fencing, besides stakes, of which more anon. When neatly set they should stand taut, like a skeleton wall about three feet high, no part of the net touching the ground, and the lower rope raised two or three inches therefrom. The meshes run four inches square, set angularly in the net—upright or "window-frame" meshes being rather an unsightly rarity. If tarred (and a net of the full length named will take up about 10 lbs. of tar) they cost from 15s. to 20s., according to the price of raw material. A clever hand should set such a net, driving the stakes as well, in from fifteen to twenty minutes for each length.

In estimating how many seasons nets will last, various matters have to be taken into consideration; much naturally depends on the usage. Can the shepherd mend his own nets? ("A stitch in time.") Does he always pack them up and keep them dry when not in use? Is the district overrun with hares? This last question is an important one. All things considered, half-a-dozen winters must be regarded as a full average.

The following extracts from the letter of a Scotch friend, Mr. Goodlet, discuss in a practical manner some of the objections made to nets :—

"I see in some discussions at Hanover Square objection taken to the use of nets for sheep, at least in game districts. First, that the hares cut them to make runs; and undoubtedly they do. The only way to meet this is to leave the opening they make unrepaired for them to run through, and they will prefer going to it again to making new ones. Their openings are always too low for the sheep to get entangled in them, and too small to let them escape.

"Another objection is that sheep get entangled in the nets and sometimes hang themselves. It is true that at first sheep will sometimes get themselves fixed in the nets, especially if they are carelessly put up; but they very soon learn to avoid this, so that we hear no complaint on this score in districts where the use of nets is established. It is one of those objections likely to

impress itself only on those who have not much experience of net-fencing, and who are frightened when they find a struggling sheep for the first day or two caught in the net; a little experience will overcome all this."

When a field has no available boundary-fence twenty nets will be required as a full allowance. But if any of these outside fences answer the purpose a proportionate deduction may be made. Let us take as an instance a twenty-acre field in the form of a parallelogram, say 20 chains long, by 10 chains wide. Then if all the fences are secure for sheep, with only 330 yards of netting the roots can be consumed to advantage. In this case the sheep will have the run of all the cleared ground, but as most of us like to keep the ploughing pretty close up, to afford a back fence another 220 yards will be required, or eleven nets in all. Therefore much depends upon the state of the external divisions.

The stakes are pitched at an average distance of three yards, or a shade less in front when guarding the turnips, and a little more apart when facing the open ground. They are chiefly made from the thinnings of larch plantations, and may consist either of whole or sawn timber. If the latter, the size will be $1\frac{3}{4}$ inches square, and the cost about $1\frac{1}{2}d.$ each: but when hooped with a stout iron ring at top (a good investment) an additional $1d.$ must be reckoned.

Hence we get at the fact that the average cost of nets and stakes together will be about $5d.$ per lineal yard. Now we can here purchase light ash sheep-hurdles 6 feet 6 inches long at $1s.$ each, stakes and irons included; so that there is only about $\frac{1}{2}d.$ per yard of difference in cost. With fair wear and careful mending these last just as long as nets, or with a heavier outlay in mending, you may reckon on even eight or nine years. A good man will manage nearly the same number of sheep—with stocking and not slicing the turnips is practised—with the one fence as with the other. Therefore for general use in the English Midland Counties, nets do not appear to offer any special advantage, even if they are equally desirable. But when you have to look to removals for any considerable distance, the case is greatly altered. Two single-horse carts will readily shift all the nets, stakes, racks, and other baggage, belonging to the Scottish shepherd. In our own case, even for removals from field to field, a similar length of fencing would make at least four two-horse waggon-loads. When racks are made to move upon wheels, the Angus man, if he has but to shift to an adjacent field, can place his nets and stakes in the racks, and then a horse with a pair of traces will complete the removal.

For Warwickshire use, the light hurdles are undoubtedly best, because hares cannot gnaw the bars through, and because the hands are better up to the setting of them. Each farmer has his own flock; the fields are smaller, and if the hounds come in sight, and the sheep get up into a corner, there is less danger of any being caught and strangled. Still I cannot call to mind any one case of death arising from strangulation.

According to the requirements of the Scottish flockmaster, the system of netting as above described is undoubtedly the best which could be adopted. It is for the English farmer, in any given case, to decide for himself which will answer his purpose best.

Mr. Swan, of Inverpeffer, near Arbroath, has favoured me with a letter calling attention to a fence for sheep of a more permanent character, which, however, admits of being occasionally removed.

He writes:—"To a tenant holding a nineteen years' lease, permanent sheep-fencing constructed with posts and top-rail of wood, and wire of the requisite size underneath, is the most convenient, and in the end the cheapest."

He recommends that the fence be set upon a soil-bank ($1\frac{1}{2}$ feet high), with a trench, to prevent the animals from rubbing against it. Such a bank may be cheaply and rapidly formed, by the aid of the plough, in a level field. He estimates the cost of gates or straining posts of larch ($7\frac{1}{2}$ feet long, and not less than 6 inches in diameter at top) at 1s. each; of the smaller larch posts (4 to 5 feet) at 3d. to $3\frac{1}{2}$ d. apiece; the top rail ($4\frac{1}{2}$ by $1\frac{1}{2}$) at 12s. or 13s. per 100 yards; the wire (Nos. 6 and 7) at 14s. per cwt. Two active men, armed with a set of wire fencing tools, which cost 25s. per set, and a bag of staples, may set up such fences, having two or three wires beside the top rail, round a twenty-acre field in a week.

To steady the fence the straining posts should be sunk at least 3 feet into the ground, and an angle rail of the size of the top rail should be firmly nailed on to the top of the principal post, across the centre of the first common post, and built against the bottom of the second. I believe that fences of this description are coming pretty extensively into use in the North.

The following Report has also been received as to the use of Nets in the East Riding of Yorkshire.

In the East Riding of Yorkshire sheep are invariably folded on turnips and rape by nets. This is considered the readiest and most economical way; indeed it would be next to impossible to

procure hurdles to fold the large flocks (from 700 to 1500 sheep) kept by the farmers in this district on turnips. Sheep are rarely if ever folded in the summer, but are depastured on clover-seeds or grass.

The nets in use are 50 yards long, made of tarred rope, with a mesh $6\frac{1}{2}$ inches wide, and when set are from $3\frac{1}{2}$ to 4 feet high. Stakes 5 feet long, sharpened at the bottom and bound at the top with a piece of hooping iron, are used for setting the nets, which have both at the top and bottom a strong line, which is wound round each stake. The price of a net is 15s., and of the stakes about 2d. each. A stake is driven in every 5 yards, and an experienced man can drive the stakes and set a net within ten minutes.

A net will last four years, provided ground game is not very abundant, but hares and rabbits cut them very much; and if an estate is overrun with these, of course the nets will not last so long. In ordinary cases the shepherd is able to repair the nets, having a supply of rope, which is rather smaller than what the net is originally made of. The expense of removing the nets, &c., is trifling. In usual winter weather a one-horse cart will take ten nets and the requisite number of stakes from one field to another.

Careless farmers occasionally put a piece of old net in the gap of a fence, and at other times protect a weak fence by setting a net at the distance of two or three feet from it. In these cases I have known very serious, indeed fatal accidents, happen to horsemen in the hunting field; and this is the only serious objection I am aware of to the use of nets. Cocoa-nut fibre has been recommended for this purpose, but I am not aware that it has been tried in this locality, and I fancy the nets would be heavier and not so portable as the ordinary hempen ones.

3.—On the Composition of Annatto.

By DR. AUGUSTUS VOELCKER.

ANNATTO is a preparation, containing a colouring matter, derived from the Orlean tree (*Bixa orellana*). This tree, or shrub, grows with an upright stem to the height of from 7 to 9 feet, sending out many branches with elm-shaped pointed leaves, having long foot-stalks. The flowers are produced in loose panicles at the end of the branches, and are of a pale peach colour. The oblong seed-pods are covered outwardly with bristles, and

enclose generally from 30 to 40 irregularly-formed seeds, of a reddish colour. The seeds and the bright red pulp in which they are enveloped are the raw materials from which the colouring matter is prepared.

This tree is a native of the warmest parts of South America, the East and West Indies, and Africa. It bears leaves all the year, and fruit which is gathered in spring.

Dr. Ure describes the preparation of annatto in the following words:—"The pods of the tree being gathered, their seeds are taken out and bruised; they are then transferred to a vat, which is called a steeper, where they are mixed with as much water as covers them.

"Here the substance is left for several weeks, or even months; it is now squeezed through sieves placed above the steeper, that the water containing the colouring matter in suspension may return into the vat. The residuum is preserved under the leaves of the pine-apple shrub till it becomes hot by fermentation. It is again subjected to the same operation, and this treatment is continued till no more colour remains.

"The substance thus extracted is passed through sieves, in order to separate the remainder of the seeds, and the colour is allowed to subside. The precipitate is boiled in coppers till it be reduced to a consistent paste; it is then suffered to cool, and dried in the shade."

There are two sorts of commercial annatto, viz. :—

1. Flag or cake annatto, which is furnished almost wholly by Cayenne. It is imported in square cakes, weighing 2 to 3 lb. each, wrapped in banana leaves, packed in casks.

2. Roll annatto, which is principally imported from Brazil. The rolls are small, not exceeding 2 or 3 ounces in weight. It is hard, dry, brownish on the outside, and beautifully red in the interior.

Annatto contains two colouring matters; one, in a pure state, is orange-red, and is called "bixin;" the other is yellow, and called "orellin." Bixin is a resinous substance, sparingly soluble in water, readily soluble in alcohol and ether, and also in fixed oils. On account of its solubility in fatty matters, to which it imparts a beautiful golden tint, it is preferred to turmeric, which it closely resembles, for colouring cheese and butter.

The alkalies readily dissolve bixin, producing a deep reddish colour. Advantage is taken of this property by the manufacturers of annatto, who, by means of potash or soda, prepare from commercial annatto a fluid extract or solid cakes, requiring no further preparation on the part of the dairy-maid.

Prepared annatto cakes are generally stamped with the name of the maker, and sold at various prices, according to quality.

Besides the alkalies used for dissolving the pure colouring matter (bixin), chalk, lime, clay, fine brick-dust, and other bulky materials are generally employed by manufacturers of solid annatto. Soft-soap, train-oil, and other disagreeable smelling and tasting matters are also said to be largely used in the manufacture of inferior annatto cakes. Good annatto cake should readily dissolve in water with a bright orange-red colour, and deposit little sediment on standing.

Inferior cakes dissolve with difficulty in water, forming a dark-brown muddy liquid, which on standing deposits a large amount of insoluble earthy matter.

A sample of superior annatto cake analysed in my laboratory gave the following results :—

Water	16.36
Organic matters	27.68
Oxides of iron and alumina	3.31
Carbonate of lime (chalk)	31.96
Magnesia .. .. .	.11
Sulphate of lime (gypsum)	2.80
Carbonate of potash	9.03
Carbonate of soda and a little chloride of sodium	6.77
Insoluble siliceous matter	1.98
	<hr/>
	100.00

It will be seen that this cake contained a great deal of chalk, added for no other purpose than to increase its weight, and give it consistency. In inferior annatto the proportion of mineral matter is always large, and that of organic matters correspondingly small.

A second and superior sample of annatto cake on analysis gave the following results :—

Moisture	16.97
Organic matters	38.00
Carbonate of potash	23.25
Chloride of sodium	1.58
Magnesia .. .. .	.92
Oxides of iron and alumina .. .. .	.37
Phosphate of lime .. .. .	.41
Sulphate of lime	3.79
Carbonate of lime	14.31
Silica .. .. .	.36
	<hr/>
	100.00

In this cake the proportion of organic matter, including pure colouring constituents, is much larger than in the preceding

samples, and on the other hand it does not contain nearly so much carbonate of lime. Altogether, this sample fairly represents the composition of the best cake annatto.

Annatto cake, even the best, has always a disagreeable smell; and it is much to be regretted that a substance which at the best is useless, and frequently is nasty, should find its way into our dairies. But so long as a good many people prefer coloured to uncoloured cheese, and show a predilection for deep-yellow-coloured butter at all times of the year, the use of annatto will continue.

If it cannot be altogether banished from the dairy, it is desirable that annatto should be employed in the best possible condition. Far superior to annatto cake, and more ready in its application, is the fluid extract, which is mainly an alkaline solution of the purified colouring matter of the *Bixa orellana*.

A sample of fluid extract of annatto, analysed by me, contained in 1000 parts:—

Water	.. .. .	848·01
Organic matters	.. .. .	43·70
Potash	.. .. .	36·20
Soda	.. .. .	26·34
Chloride of sodium	∴ .. .	5·09
Oxides of iron and alumina	.. .. .	·72
Lime	.. .. .	·44
Magnesia	.. .. .	·16
Phosphoric acid	.. .. .	·53
Sulphuric acid	.. .. .	6·96
Carbonic acid and loss	.. .. .	31·85

1000·00

Liquid annatto is now manufactured in England by several makers, amongst others, by Mr. Nichols, of Chippenham. His fluid extract of annatto is perfectly clear, has a bright orange colour, and is free from any of the obnoxious and disagreeable substances which frequently occur in annatto cake.

12, *Hanover Square, London, July, 1863.*

4.—*Letter to the Editor, from Mr. J. FRANCIS CLARK, on a Cheap Material for Farm Buildings.*

MY DEAR SIR,

ACCORDING to promise, I send you a short account of the homestead which I have lately erected for my own farm at Abbots Roding.

My plan included the usual buildings sufficient for a farm of

200 acres—barn, stables, cart-lodge, granary, cowhouse, sheds, piggeries, &c. ; and its only peculiarity was that the walls were all formed of concrete blocks. These blocks were composed of flint-stones, sand, and lime, in the proportion of 6 parts stones, 3 parts sand, and $1\frac{1}{2}$ part pulverized lime, each block being 12 in. \times 6 in. \times 6 in. The cost of making a sufficient number to complete a superficial rod, 272 ft., including materials and cartage, was 3*l.* 17*s.*

There were 40 rods of work in the walls, which, made with concrete blocks, cost 180*l.* ; and if built with bricks, would cost from 400*l.* to 480*l.*, according to situation. By these means, therefore, a saving of more than 200*l.* was effected, and a convenient homestead of a very durable character made at an outlay not exceeding 700*l.* in all.

In localities where sand and stones abound, but bricks are expensive, the substitution of concrete blocks for brickwork may be of service.

I am, dear Sir, yours very truly,

J. F. CLARK.

Newmarket.

5.—Dairy Practice.

MR. EGERTON HARDING, of Old Springs, Market Drayton, has furnished the following statistical account of the produce from a stock of milking cows kept upon a dairy farm, of which he was both landlord and tenant for 11 years.

The farm contains 133 acres, of which 67 are pasture and meadow. The rent, tithe free, was 200*l.* The cows were cross-bred, but of a short-horn character.

PRODUCE OF MILKING COWS.

	Amounts received for Cheese.			Amounts received for Butter.			Amounts received for Milk.			Amounts received for Calves.			Balances from Sales and Valuation of Stock.			Amounts received for Cheese, Butter, Milk, Calves, and Beef.			
	£.	s.	d.	£.	s.	d.	£.	s.	d.	£.	s.	d.	+	£.	s.	d.	£.	s.	d.
1852	261	14	1½	68	6	8½	14	5	7	14	11	0	+	43	11	6	404	8	11
1853	334	11	9½	94	3	10	13	11	7½	12	1	6	—	8	18	0	445	11	9½
1854	272	8	8½	89	12	10½	13	14	4½	30	15	6	+	6	5	6	412	12	11½
1855	389	19	4½	92	6	6	12	14	4	14	12	0	+	16	17	0	466	9	2½
1856	330	15	6½	92	6	8½	12	16	4	33	11	0	+	26	8	0	495	17	7
1857	305	2	0	81	11	4½	17	19	10½	30	10	6	+	4	4	6	338	18	3
1858	286	10	0	91	0	3½	19	11	11	27	5	6	+	28	0	9	432	8	5½
1859	379	18	10	91	1	1	20	12	2	16	13	4	+	57	9	5	475	14	10
1860	289	5	8	77	13	4	22	12	1	26	5	2	—	5	3	2	414	3	1
1861	160	4	7	68	11	5	19	5	3	15	6	0	+	54	13	0	318	0	8
1862	173	13	0	64	7	6	19	15	1	6	6	6	+	100	16	8	364	18	9
Aver. of 11 Years	265	16	8½	82	17	0½	16	19	10½	21	12	6½		29	13	2½	417	4	3

PRODUCE OF MILKING COWS—*continued.*

	Amounts received for Cheese, Butter, Milk, and Calves.			Average No. of Cattle on the Farm.	Average No. of Milking Cows.	Amounts received per head of Cattle.			Amounts received per Milking Cow.			Price of Best Cheese per lb.	Price of Skim Cheese per lb.	Price of Butter per lb.	Price of Beef per lb.
	£.	s.	d.			£.	s.	d.	£.	s.	d.	d.	d.	d.	d.
1852	354	17	5	25	24	16	3	6	14	14	10	5½	3	10	6
1853	454	8	9½	27	26	16	10	0	17	9	1½	6½	3½	10	6½
1854	406	7	5½	27	27	15	5	8	15	1	0	6½	3	10½	6½
1855	449	12	2½	26½	25	17	12	0	17	19	8	6½	3	11	6½
1856	469	9	7	27	26	18	7	3	18	1	1	6½	3½	12	5½
1857	334	13	9	28	26	11	14	11	12	15	11	4½	3½	12	5½
1858	424	7	8½	29½	26	15	6	8	16	6	5	5½	3½	12	6½
1859	418	5	8	30	27	15	17	1	15	9	9½	5½	3	14	6½
1860	419	6	3	27	26	15	4	0	16	2	6½	6½	3	14	6½
1861	263	7	3	28	27	11	5	1	9	15	0½	4	3	14	6
1862	264	2	1	28	25	13	0	8	10	11	3½	4½	0	14	6½
Aver. of 11 Years	387	10	9	27½	25½	15	2	5½	14	19	3	5½	2½	12	6½

	No. of Best Cheeses.	Weight per Cheese.	Total Weight.	No. of Skim Cheeses.	Weight per Cheese.	Total Weight.	No. of Sultons.	Weight per Cheese.	Total Weight.	Total Weights of all Cheeses.				Weight per Cow.
		lbs.	lbs.		lbs.	lbs.		lbs.	lbs.	lbs.	T. cows.	qrs.	lbs.	lbs.
1852	238	47½	11,336	62	14½	900	0	0	0	12,230	5	9	1	569
1853	222	55½	12,305	64	16½	1035	0	0	0	13,400	5	19	2	515
1854	224	44	9,893	54	14	798	0	0	0	10,661	4	15	3	393
1855	240	50½	12,136	50	13½	695	4	11	44	12,875	5	13	3	515
1856	247	49	12,110	38	13	497	8	10½	86	12,693	5	13	1	498
1857	242	41½	10,006	30	12½	370	4	11	44	10,420	4	13	0	400
1858	273	40	11,965	17	25	425	4	16½	41	12,431	5	10	3	488
1859	243	45½	11,170	26	13½	349	4	12	48	11,567	5	3	1	465
1860	227	46½	10,541	19	10	184	4	11½	47	10,771	4	16	0	414
1861	213	41½	8,893	9	13½	120	4	10½	43	9,046	4	0	3	335
1862	194	42½	8,296	0	0	0	4	10½	43	8,339	3	14	1	333
Aver. of 11 Years	233	45½	10,785½	33½	14½	488½	3½	11	36	11,312½	5	1	0	441½

In addition to grass, straw, hay, and roots, the produce of the farm, each cow had, night and morning, a small feed of purchased corn, which cost about 4*l.* per head per annum.

6.—*Homœopathic Treatment of Cattle for Lung Disease and other Inflammatory Attacks.* By P. H. FRERE.

At a recent monthly council the Duke of Marlborough called the attention of the Society to the treatment of diseases in cattle by homœopathic remedies; the occasion was not adapted for a prolonged discussion of the subject, and further opportunities will probably occur for its full consideration. Meanwhile, since

another autumn season will have passed before our discussions are renewed, I will give a short account of my own experience, which may be some guide to those who are already hesitating what course to pursue in dealing with cases of lung disease. I was induced to try homœopathic treatment two years ago—1st, Because it is my wish to test everything which may possibly be of service to agriculture; 2ndly, Because I believe that all medical treatment rests, and must rest, on an empirical and shifting basis rather than on the mature conclusions of reason; 3rdly, Because the trial of medical agents, one at a time, is the only means of attaining distinct knowledge of their properties; and lastly, Because, in dealing with fattening stock exposed to lung disease, the question lay practically between this treatment and none, the knife being preferable to the prospect of a tainted carcass, or of an impaired constitution and a long doctor's bill.

My experience at first was far from encouraging. Of a supplementary lot of 8 polled Scots, bought late in the autumn of 1861, 4 were attacked, and of these, 2 died under homœopathic treatment, and 1 was sold for 5*l*. A well-known practitioner came down from London to see them for a day, and on the whole they were treated according to his rules. When in the autumn of 1862 disease of the same nature broke out apparently with the same malignity in 4 cases among some 25 bullocks, I agreed with my manager that he should, at his discretion, employ the same remedies as before; but instead of allowing 2 or 3 hours to elapse between the doses, as our books direct, *should repeat them every half hour or hour, at the first, until he appeared to make some impression on the animal.* This direction was specially applicable to the feverish symptoms which aconite has to cope with, and the sluggish inertness for which bryonia may be given. To special skill in the treatment we of course make no pretensions; in this respect any farmer who has watched the symptoms of lung disease with care may exercise as good a judgment as ourselves. I shall only wish to show that in 2 cases especially the attack while it lasted was very acute, that it was of the *nature* of lung disease, and that the animals not only recovered, but thrived and fattened, and were sold at good prices.

The first case of illness occurred in a 2-year-old bullock on December 12, 1862. Our memoranda show that first aconite, then aconite and bryonia alternately, were given every hour; "4th day, no better, ammonium causticum, 12 drops every hour and half; 5th day, phosphorus every hour; 7th day, bryonia and

556 *Homœopathic Treatment of Cattle for Lung Disease*

phosphorus every 2 hours; 11th day, better." The bullock was sold the 31st of March for 16*l.* 16*s.*, weight 42 stone 9 lbs.

This young bullock weighed:—

						Cwts.	qrs.	lbs.
October 23, 1862	..	..	..	..	..	7	3	0
November 14, "	..	..	..	..	..	8	2	0
March 6, 1863 (after illness)	..	..	..	..	..	9	3	20
March 31, "	..	..	..	..	..	10	2	0

After death an eminent anatomist in Cambridge looked at the lungs with me; we found that about one-sixth of the right lung (the anterior part) was congested; a gathering had also been formed, emphysema existed, and by adhesion of the lung to the rib several pounds of meat were blackened and spoilt; the rest of the carcase was of excellent quality, and part of it was served at my own table.

I consider that the loss occasioned by this attack was little more than the cost of one month's keep; this bullock when recovering had learned to take gruel and fattening drinks, and, continuing to do so, gained ground fully as fast as any beast I had. I wish they would all take kindly to drinking water thickened with wheat or linseed-meal, &c.

The second severe case was that of a young bullock taken ill January 5, 1863. I shall state memoranda of his treatment simply to show the acuteness and duration of his attack, which resisted all our first remedies:—

"Jan 5th. Aconite every half hour.

"6th. Bryonia every hour.

"7th. Much worse; no appetite; phosphorus every hour.

"9th. No better; breathing bad; pain in chest; nux and antimony.

"12th. Much trembling; skin hot and dry; ammonium causticum every half hour.

"15. Expected to die every hour; it lay down 3 days and nights, and was fed with gruel; arsenicum and mercurius vivus 4 grains, in turns, for 2 or 3 days; aconite at night.

"18th and 19th. A little better; phosphorus every hour.

"21st. Better; ate a little.

"25th. Much better.

"29th. Ate a little mangold."

The live-weights of this young bullock were:—

						Cwts.	qrs.	lbs.
November 14	..	..	..	..	..	8	2	0
December 12	..	..	..	..	..	8	3	6
February 27 (after illness)	..	..	..	..	..	8	2	8
May 9 ..	..	..	..	..	..	9	3	0
May 29	..	..	..	..	..	10	2	6
June 17	..	..	..	..	..	10	3	6
July 9 ..	..	..	..	..	..	10	3	29

It was sold on the 22nd of July for 21*l*.; weight, 50 stone. The lungs of this bullock were sent to Professor Simonds, who has reported to me, chiefly by word of mouth, to the following effect:—

“There was evidence in the lungs of your bullock, of lung-disease, though of a slight nature. A small portion of the lung had become separated from the healthy lung structure, as is the case in the majority of instances of recovery from pleuro-pneumonia.” [There was an adhesion of both lungs to the pleura, but no meat was damaged.]

I do not anticipate that in young and previously healthy animals a single attack promptly met will permanently destroy a considerable part of the structure of the lung; if it would, the animal would hardly be expected to fatten afterwards.

Our own memoranda show that the attack was long and acute; men of experience on the spot offered almost any odds that the animal would die in 48 hours; it was reduced to a mere bag of bones, yet its rallying powers were such that the result of the attack was merely a delay of six or eight weeks in the time, not in the conditions, of the sale, with a charge for a few shilling bottles of medicine.

Lastly, I will refer briefly to a case which was never attended with danger, because the weighing of the animal was consequently not interrupted; yet even here the loss of weight shows that the attack was in some degree serious. This bullock was taken ill January 5, 1863; he had aconite and bryonia for four or five days; phosphorus and sulphur completed his treatment. It will be observed that he was weighed on the 4th day of the attack, and had then lost 1½ cwt. instead of gaining about 56 lbs. since the last monthly weighing:—

					Cwts.	qrs.	lbs.
Weight,	December 12, 1862	..	..	..	10	3	0
„	January 9, 1863	..	..	..	9	1	0
„	February 6, „	..	..	..	10	0	23
„	March 6, „	..	..	..	10	2	28
„	April 2, „	..	..	..	11	0	12
„	May 1, „	..	..	..	11	3	6
„	July 9, „	..	..	..	12	2	6

Sold for 23*l*., July 23rd. Carcase, 55 stone.

Thus in every case we had to deal with, the animal was sold fat, whilst several of my neighbours suffered from like attacks, and sacrificed their bullocks. One farmer near me lost by death or forced sale more than half of a lot of 30 bullocks which he bought in the same fair from which mine came.

In short, I think it is worth a farmer's while to have by him some homœopathic remedies and a book for his guide, and in using them, to keep up a brisk fire, but not increase "the charge." The Duke of Marlborough recommends a treatise by 'A London Cowman,' which he found useful for very malignant lung disease, and also for foot and mouth disease, and for milk fever in calves. I hope that in 1864 this subject will be treated on a larger scale.

ABSTRACT REPORT OF AGRICULTURAL DISCUSSIONS.

Meeting of Weekly Council, February 25, 1863. Mr. RAYMOND BARKER in the Chair. Lecture by Mr. JOHN TAYLOR, junr., of 53, Parliament-street,

ON MATERIALS FOR THE CONSTRUCTION OF COTTAGES.

Mr. TAYLOR said he felt honoured by the request which was made to him to attend there to explain his various improvements in construction, and to show how far they are applicable to cottages for agricultural labourers, and to agricultural buildings. He need not say anything to show the great necessity there was for improved cottages; neither did he propose to exhibit any particular plan for cottages, except for the purpose of showing how his materials were introduced. Any attempt to draw a perfect model of a cottage must fail, because families are so differently constituted that no one plan can be universally applicable. He wished to speak of the general defects in cottage building, and more particularly of damp—the principal source of the diseases from which the dwellers in cottages suffer. Now, the description of cottage to which he wished first to allude was a cottage with three bedrooms, a kitchen or living-room on the ground floor, and a washhouse or scullery. In the plan exhibited there is in the centre a party-wall; a gable in front, and a gable at the back, that is to say, a common lean-to roof. The timbers lean from the centre of the roof down on to the side-wall. Thus were avoided all intricacies of roof, and a great deal of expense. There were no valleys or gutters, but along the side-wall was a single rain-water trough, and all the water ran down through one pipe into a water-butt. The framing of the roof was the simplest, and it was a perfectly square building, presenting the smallest external surface—a great object in our very damp climate. Another plan of cottages was one which he designed only last week, and was going to erect at Bishop's Waltham for the use of workmen there. This was a modification of the former plan. It would, he thought, be a mistake to build all cottages with three bedrooms. In some cases it was necessary to have three rooms, in others it was not. He had made a design for a pair of cottages in accordance with a suggestion of Mr. Frere, that it might be a very convenient arrangement to have a sleeping-room for boys on the ground-floor, midway between the two dwellings. He thought that when the cottage was erected there should be two doorways in the brickwork, and that one of them should be bricked up; that door being open which communicated with the cottage in which a third bedroom was required; the other house would suffice for a man and his wife who had only small children. Up above was the girls' room, and in front the parents' room. The elevation and construction of the roof were mainly the same as before. The next was a plan for some almshouses which he was about to erect for Colonel Harcourt, in Sussex.

Now, in proceeding to speak of the defects of cottages generally, he would commence with the foundations. They must, he thought, all be aware of the evils of damp, drawn upwards by capillary attraction; this damp had frequently been observed to rise to a height of five or six feet. Rain absorbed as it falls upon a building is bad enough; but they must consider all the impurities that accompany the moisture that is brought up from the earth to estimate the full extent of the evil of damp rising by capillary attraction. The poor, living in cottages, generally endeavoured to keep up the temperature by keeping out the air, and so made the interior of the cottage warm; and the warmer it was, the greater, of course, was the amount of evaporation.

Two or three things were generally used, though not so often as they should be, on account of the expense, to keep down damp. There were slates laid in cement, and asphalte. With slates in cement the work is frequently very imperfectly done; and where that is the case the damp rises up quicker in some parts. To meet this case he had provided a damp-proof course, made of brown stoneware—a material which was often used, on account of its hardness, imperviousness, and durability, for drainage purposes. It was made by earth being expressed through a die, and perforated. These materials would be useless if they were obliged to be put together by means of a mortar or cement joint, because the water would rise up; but the joint was a section of one of the perforations. The two joints being brought together, that is to say, the two slabs being laid alongside each other, there is an open-air space right through the joint; and if the house is built over a pond of water, nothing could rise above that. These materials are as ready to the bricklayer's hands as an ordinary brick, and as easily laid. They also answer a further purpose besides keeping down damp. Air-bricks are generally used for giving a current of air and preventing dry-rot under a wooden floor. But air-bricks are generally insufficient for the purpose; the air which they introduce is small in amount and limited in range; and they are frequently put in the wrong place. Here, however, is a perforated course of bricks all round the building, producing a thorough circulation of air.

Another requirement in a foundation is bonding, or strength. The best thing for that purpose is a layer of York stone; but it is too expensive to be generally used. The material which he had mentioned is as strong as York stone; for it bore 600 feet of brickwork upon it. By its use damp is kept down, and all the air that is necessary introduced into the building.*

He would next speak of the construction of the walls. They often saw the walls of cottages constructed of 9-inch brickwork. Now, he considered that a brick wall only 9 inches thick was unfit to form the habitation of any human being. The through mortar-joint in the brickwork is a constant source of wet, which is conveyed from the exterior to the interior. They all knew that good bricks were always absorbent. Suppose there were a continuous rain, causing the bricks to absorb as much water as they could; the first drying wind would

* See Illustration No. 1 at the end of this Report.

dry the outside; the next rain would complete the absorption, and the bricks would scarcely ever be dried through, unless by the warmth of the interior. Again, a nine-inch wall, though strong enough for the purpose, was not stiff enough. It was so yielding that, as the wall was being built, it would oscillate when a man goes up a ladder, owing to the yielding nature of the mortar joints. Now, he thought that, in order to construct cottages economically, they must always obtain the bulk of the materials near the spot, the expense of conveying them being prohibitory; therefore, he proposed to send a small quantity of materials to the place, to be used with the local materials. Accordingly, he made a perforated block, expressed through dies in an ordinary brick-machine; these facing-blocks are made in pairs, to give facilities in drying and burning. Such a brick, if not made in pairs, would never dry straight, but would warp and twist in various ways, and thus cause much trouble. Or again, the bricks would be liable to be broken in railway transit. When the bricklayer touched a block at a certain point with the chisel, it immediately became two bricks.* He then commenced by laying a course of common bricks which were called headers, after which he took one of these blocks and laid it upon the headers. Then he took the ordinary bricks, and laid a course inside the wall—all stretchers; then another of these facing-blocks; and then he repeated the headers. The facing-block rendered the wall perfectly stiff. It had no more bulk than the ordinary 9-inch wall, because the cubical contents of the 9-inch were spread, making it 11 inches, and naturally producing a perfectly dry area everywhere within the internal face, leaving that face dry. The inside of the brickwork was perfectly true. It was a well-known fact that no 9-inch wall could ever be true outside and inside; the different sizes of the bricks always presented unevenness on the inside. With his system there was, except for appearance and comfort, no necessity for interior plastering, because the wall could be made perfectly fair inside. Thus, he had shown the improvement which he proposed to make in brick construction.

One material which abounds in every locality, even where bricks were expensive, is concrete. Concrete, or materials for concrete, are everywhere to be found; but hitherto it has not been available for the construction of walls. Concrete in a foundation would bear any weight which may be put upon it, because it was retained in the trench, that is, it was prevented from spreading; but when it is used in building walls, the usual course is to put up some temporary boards on the outside and inside face; the concrete is then poured into those boards; when it is sufficiently hardened the boards are removed, and placed a little higher up; and so the process goes on. But as the removal of the boards exposes it to the action of the external air, the concrete immediately begins to decay, not being adapted to bear such exposure. Then, it will not bear cross strain, because it depends wholly on the cementitious qualities of the mortar. It soon begins to resolve itself into its original formation, and settlements take place, showing

* See Illustration No. 2.

defective construction. The truth is, that concrete requires to be used, as it were, in a trench. Now, here* are two facing-blocks constructed on the same principle as those already shown to be applicable for brickwork, but of a different form. Suppose the wall to be faced on two sides, the bricklayer lays a course of these bricks on the outside and on the inside, to form the thickness; the labourer follows, pouring concrete into the trench thus formed. It would be observed that the pressure of the concrete on the flange counteracts the outward thrust given by the concrete, and thus the concrete is retained just in the same way as in the foundation of a building. He had built houses costing four or five thousand pounds a-piece, where economy was no object, upon that plan of construction. Instead of the board being removed, the blocks, which are a substitute for the board, remain to protect the concrete from the external atmosphere; and such a wall is as hard and stronger than the very best brick construction; or again the brick face in the interior might be dispensed with.†

He would now show how it happens that blocks of this particular form are cheap enough to be used for cottage building. It is entirely owing to the contrivance by which they are burnt in blocks of six together. The blocks are all exactly alike in form, and when passing through the die they are held together by clay which had been left between the knives or cutters. The block which he now produced represented six bricks 12 inches long. Hitherto it had been almost an impossibility, even when persons went to the greatest expense, to manufacture a brick true enough to be used 12 inches in length. With this plan of moulding, the joints are found to be straighter and truer than they had been in the very best descriptions of work previously. Then again, there is the great economy of conveying to the building such a very small weight of materials. When it was considered that these blocks represented twelve bricks on the external face of the wall, it would be readily understood that very few such blocks would be necessary to construct concrete walls for a cottage.

The next point to be considered is the flooring. They all knew the advantages in warmth and comfort of a wooden floor over a brick or tile floor. Yet a wooden floor has some drawbacks; for example, if a house is left uninhabited for a short time, a quantity of fleas and other insects immediately find a habitation there. But a paved floor was generally considered, and with good reason, to be cold and liable to damp. Now, the paving tile which he exhibited ‡ had a flange on one side. This flange extends beyond the face of the tile, so that the tile rests on the flange of its neighbour. Longitudinally some openings are formed, by leaving out a small portion of that flange, so that the air circulates not only longitudinally, from one end to the other beneath the paving, but also transversely. There is, in short, a perfect current of air everywhere beneath the paving. They must often have observed that floor-paving got slightly out of the level. It is generally supposed that this arises from one tile being softer than

* See Illustration No. 3.

† See Illustration No. 4.

‡ See Illustration No. 5.

another; but that is not always the case; the cause is frequently to be found in the surface on which the tile rested, causing it to sink slightly, leaving another more exposed, in consequence, to wear. Now, the tiles exhibited rested one upon another on thin flanges representing a level platform, and the paving kept its level much better than when it rested solely on the soil. These tiles were made of Staffordshire clay, and were kiln-burnt; they were all made in pairs, on the same principle as the blocks which he had before described. The commencing and the finishing tiles were produced from the same die; and it was because of these facilities in manufacture these materials are cheaply produced.

He now came to roofing. Tiling is better for that purpose than slating; but in and around London it is much more costly, the difference being 35 per cent., at least. The great advantage of slating is that it requires less strength of timber. Ordinary plain tiling is nearly three times the weight of slating, because it has to be doubled in order to keep out water. A tiled roof is much warmer in winter and cooler in summer than a slated roof. Now, he had invented a roof which was only half the weight of plain tiling, and very little heavier than slating, as it does not require to be doubled.* This tile is made with two side flanges, there being notches in the flanges. These notches allowed the tile when turned topsy-turvy to go down and take a level bearing upon the two side-tiles beneath. They also presented a level bed everywhere for the tile to rest upon. On the face of the tile there is a nib, which gives the gauge, secures the upper tile against the lower one, and when turned up is of equal use in keeping one down upon the other. The ridging, which is generally the most defective part of slate roofing, is adequately provided for in the same manner as the tiling, the ridge being merely a continuation of the tile. The upper ridge-tile rests upon the under ridge-tile, and the under ridge-tile upon the tiling, capping the whole. Thus, without any other aid, perfect dryness is secured in the most exposed part of the ridge. The ridge is mortared down and bedded in the usual way.

There are many more points of construction to which attention is necessary for the prevention of damp in cottages. They must have often observed how much window-sills, chimney-cappings, and other exposed parts require what is termed weathering. Now, for that purpose he had formed what he called a drip-band, which is suitable in its formation for cottages. This kind of band is used at all the stations of the London, Chatham, and Dover Railway Company, and therefore it has been sufficiently tried. The band has a throat beneath it, which projects just far enough to allow any moisture to drip from one band on to another, and thus wet is prevented from running down the face of the wall.

Mr. TAYLOR said, in reply to an inquiry, that the depth beneath the ground-floor of the cottages described varied from six to ten inches, which is all that is necessary. The heavy expense required for

* See Illustration No. 6.

sleepers, timbers, and so on, is avoided. He believed that in most instances it would be found better to build on the surface of the soil than to go down 18 inches. In this case there is no necessity to go to an extra depth for the foundation, as is done where there are wood floors.

Having now shown generally the application of these different materials, he would next call attention to artificial warming by means of open fire-places.* He proposed merely to explain the principle of his invention, not the exact stove applicable for a cottage, because at present he had been unable to get one sufficiently cheap for that purpose. He had put these stoves in some new cottages for the Queen, at a price not less than $2\frac{1}{2}$ guineas; but he mentioned the subject now, because he expected shortly to supply a stove with many—if not quite all—the advantages of the one which he had mentioned, at a price suited to a labourer's cottage. In an ordinary fire-place, when a fire was burning, it fed itself with the cold air which came in through the door or window; the greater the warmth received by a person standing before the fire, the greater was the draught. The second defect is that 75 per cent. of the heat from the fuel rushes up the chimney, and is of no advantage for warming the room; the third is the evil arising from smoke—that is, from the soot or carbon that is in smoke.

They all knew, from looking at the public buildings, how much they were disfigured and injured by the action of smoke. Hence, there have been many attempts made to consume smoke in open fire-places. The most successful of these was that of Dr. Arnott—an exceedingly clever contrivance, fully answering its purpose when a gentleman can attend to it himself in his library; but, if left to the care of a domestic servant, as is very apt to be the case, it soon comes to be used as a common fire-place, and then it is a very bad description of common fire-place. Now, he must ask them to bear in mind that smoke was the effect of imperfect combustion. There is no smoke in the lower part of the fire, where the greatest heat is; but in the upper part smoke is thrown off and ascends. He allowed it to ascend, but instead of ascending up the chimney, it meets with the closed register; the smoke, thus checked, passes down, and comes through the fire; there the carbon which it contains is consumed as fuel, and the residue continues its course, and goes up the chimney. The heated air charged with smoke which would have gone up the chimney now passes round to heat the hollow parts around the fire-place. These are, as it were, between two fires—the fire on their inside, and the smoke on their outside; and they communicate with the cold external air, or the cold air of the room, at pleasure. Thus there is in the room a large quantity of moderately warm air, not air heated by coming in contact with over-heated surfaces. Thus, all the three defects which he had pointed out as existing in the ordinary fire-places are remedied by his stove. The carbon in the smoke is consumed without any trouble; the heat which would have escaped up

* See Illustration No. 7.

the chimney is made use of, and the room, instead of being filled with cold air through the door or window, is supplied with moderately warm air. This stove is, moreover, a remedy for that very great evil, a smoky chimney. The only reason why smoke does not as readily go out of the door or window as up the chimney, is, that the air in the chimney is rarified; the more it is rarified, the better smoke-flue, or smoke-shaft, it becomes. But in an ordinary fire-place the air rushes up and makes the chimney cool; and thus it becomes such a bad smoke-shaft that the least opposition—fire burning in another part of the house, and a hundred other causes—cause smoke to appear in the room. No air could pass up his chimney but what had become heated; and thus the common smoke-flue is made not only a perfect smoke-draught, but also a valuable shaft for the purpose of ventilation. The clever contrivance of Dr. Arnott had the effect of preventing any down draught; that is to say, the moment the flue becomes unpleasant as a ventilating shaft, as is frequently the case, Dr. Arnott's valve operates as a check. He would not then enter into the question how far that valve is sufficient for the purpose. Stains of smoke are often produced by it; and it is not every one who can bear the noise and flapping which the valve produces. In his own flue there is no necessity for any contrivance of that description. He merely made an ordinary opening into the smoke-flue, being quite certain that as long as the smoke was burning it could be used as a powerful extracting shaft for ventilation. These fire-places have perforated tiles and iron work, which stand in front of the fire-lumps, and present an ornamental appearance in the room. He thought he had now occupied the time and attention of the meeting long enough; but he should be happy to answer any questions which might be put to him.

In answer to an inquiry how these chimneys were swept, Mr. TAYLOR said that about every six weeks or two months a broom was used, which was made like a ball, with a string and bullet. A clerk in his office swept his chimney without soiling his hands. He put his hand up, and a bullet dropped on to the bottom hearth, where the cinders generally dropped. The bullet deposited the soot on the hearth, and it was taken away with the cinders. This plan had been in operation for two or three years, and he had never been troubled with a particle of soot. Sometimes the register was left open, in order to cool the room. He thought that a sweep would not be required more than once in five or six years.

Mr. BAILEY DENTON believed that no lecture was ever prepared with greater care than this; that Mr. Taylor's inventions were exceedingly ingenious, and would come into extensive use; but still the question recurred, what would be the expense of building these cottages? His own experience in cottage-building was not small, and, taking advantage of every improvement that had been made, he did not see how cottages were to be built for less than 120*l.* each, supposing that they were built in pairs, with three bed-rooms, that sanitary requirements were respected, and that the requirements of the Enclosure Commis-

sioners for cottages built on entailed estates were also fulfilled. It would be well, he thought, for all landowners to consider whether it is not desirable that, when cottages are built on their estates, the rules laid down by the Enclosure Commissioners to secure substantiality, should be observed. If cottages require constant repairs, they are a curse, rather than a benefit, to an estate. Assuming that cottages were built in pairs, and in accordance with the views of modern philosophers as regarded sanitary arrangements, and that the cost per pair would be 250*l.*—and, notwithstanding the greatest regard to economy, the expense had run up to 300*l.*—the question arose, who was to pay for them? It resolved itself into a question of interest. Nobody built houses without looking for a return of six, seven, or eight per cent.; and no landowner would, whatever might be the extent of his philanthropy, build cottages without regard to cost. A return of six per cent. would require a rent of at least 7*l.* 10*s.* for each cottage. Again, he asked, who was to pay? The cottager could not afford to pay such a rent. The utmost proportion of his earnings which he could afford for rent was a seventh. A man who was earning 9*s.* or 10*s.* a week—and there were a great many men with families who did not earn more—could not pay more than 1*s.* 6*d.*; a man who earned 14*s.*, could not pay more than 2*s.*; and the highest-paid agricultural labourers could not afford more than 2*s.* 6*d.* or 2*s.* 9*d.* Assuming that 2*s.* per week was the mean payment for cottage-rent, that made 5*l.* a year, or only two-thirds of what was required to pay interest on capital. Who, then, was to pay the remainder? He knew no question which was more deserving of the consideration of this Society. That was the point on which he desired to lay stress, and which had, in fact, brought him there that day. He thought that if good cottages were built on the farms, the tenants, who had the advantage of having the labourer living upon the spot, instead of the disadvantage of his losing his strength in walking a long distance to it, could afford to pay something; and it was a point well worthy of the consideration of tenants whether, under such circumstances, they should not contribute a portion of the rent. Then there was a third party—the owner of the estate—of whose farms were improved by the building of cottages, and whose property generally derived a corresponding advantage. Whether the owners and the farmers were prepared to contribute the difference between 1*s.* 6*d.* a week, which was about 4*l.* a year, and 7*l.* 10*s.* was another question; but certain it was that the building of improved cottages could not be expected to increase very largely unless that question was well considered and practically answered. It was not to be expected that all owners would imitate the Duke of Bedford, and Mr. Turner of Lincolnshire, who had built such beautiful cottages, but so costly, that he was sure no labourer could pay an adequate rent.

The CHAIRMAN thought the question before the meeting related to the materials for building cottages: he hoped that some day or other they would have a discussion on the economical view of the matter. He could not help remarking that he knew two or three landlords who

had the strongest objection to there being a third bedroom in a labourer's cottage, because it often led the cottager to receive that pest and nuisance—a lodger. Mr. Taylor had not given the dimensions of the rooms.

Mr. TAYLOR explained that he prefaced his remarks by saying that he had not come there to show any particular plan of cottage-buildings. Had he done so, his statement would have been most incomplete unless it included an estimate of what the cottage might be built for; and estimates were generally so fallacious that he was quite sure that would have done no good, and no one would have given him credit for accuracy. His object was, therefore, simply to show improved and cheap modes of constructing cottages; and with that view he mentioned four special points for consideration—the foundation, the walls, the roofing, and the paving. Any gentleman who wanted to build a cottage might ascertain for himself how much a yard he would have to pay for concrete on the spot, and what would be the cost of bricks. It was calculated that a rod of ordinary brickwork would require 4352 bricks, which, at 32s. per thousand, would cost 7l. On the other hand, a rod of the patent walling would require 1450 bricks, which, at 20s. per thousand—that being the price for labourers' cottages only, in which case he charged no royalty—would cost 1l. 16s. 3d. Add to this the cubical contents of the concrete required, namely, 9½ yards, at 16s. 8d. (taking the gravel at 2s., and the lime at 10s.), there was 1l. 12s. 8d., making a total of 3l. 8s. 11d. per rod of 14-inch work, as against 7l. per rod of brickwork. In this calculation it was assumed that there would not be more than the ordinary amount of expense for conveyance. The materials might be made on any estate where there was plenty of good clay.

He had spoken of the cost of materials only, assuming that the cost of scaffolding, labour, &c., would be about the same as with ordinary brickwork—neither more nor less.

As to the weight of patent brickwork, the materials are, in fact, so light that almost enough to build a cottage might be sent in a railway truck; 4350 common bricks would weigh 9 tons 14 cwt., while 1450 of his patent bricks would weigh only 1 ton 9 cwt. Thus it would be seen that the cost of carriage in the case of his materials was exceedingly low. His patent roof tiles weighed about 656 lbs. per square; plain tiling weighed about 1624 lbs. per square. Pantiles would generally weigh about one-half. A roof so constructed might possibly be colder than an ordinary roof; but an air-tight roof he considered unhealthy. One great object is ventilation. The clay of which tiles are made is frequently so porous that water would filter through it; and it is well known in tile-making districts that a porous tile would withstand the action of frost better than one which is non-porous. If they wished to have a perfect tile-roof, they should take care that the tiles were porous.

He had shown that paving on his principle would be drier, and therefore warmer than ordinary paving; and with that paving there was no necessity for the sleepers and brickwork required under a wooden floor. The gentleman who thought that cottages must cost

about 125*l.* a-piece, ought to take all these savings into account. He would give them the result of his calculations with respect to the cottages which he was going to build at Bishop's Waltham. Those cottages were to be erected near some brickworks, for men who were employed at those works. These men—many of whom were earning 30*s.* a week—thought it very hard that they should have to pay 6*s.* a week for a cottage; and consequently economy was an object in that case, as well as in the case of cottages intended for persons earning only 10*s.* a week. He estimated that these cottages would cost 90*l.* a piece, exclusive of a well and the oven. The cottage with three bedrooms, of which he had spoken, would, he believed, cost 100*l.* In this plan the living-room was 12 feet square, with a height of 8 feet. The height of the bedrooms averaged 8 feet 6 inches.

Dr. CRISP wished to say a few words with respect to Mr. Taylor's opinion, that the badness of the materials of cottages of the old kind, and especially the damp which arose from them, had been a great source of illness in the rural districts. In his younger days he had a good deal to do with the treatment of disease amongst the peasantry, and he did not remember a single case in which illness was occasioned by a damp cottage. The sources of illness were unfortunately very abundant—an unhealthy locality, the holes in which cottages are always placed, and the badness of the water obtained from wells and ponds, are frightful causes of disease. If the cottages of the rural population be compared with the dwellings of the poor in London, although some moral defects in the former exist, and the occupants are generally too much crowded and huddled together, still the comparison is in their favour. Statistics certainly did not show that much disease arose from the ill-construction of the cottages; they rather tended to show that it arose from malaria and such like influences. A roof like that recommended by Mr. Taylor would, he imagined, be extremely hot in summer, and cold in winter. A thatch roof had a great advantage, in point of warmth, over both tile and slate.

Mr. Taylor's grate could never be used generally in cottages where wood was continually burnt, and his impression was that it would be constantly out of order.

He might just state that an Exmoor cottage could be built for 60*l.*, the materials being obtained on the spot. In the Bath and West of England Society's Journal several plans are given for building cheap cottages. After all everything hinges on the question of cost; and he hoped that that part of the question would be entertained more fully on some future occasion.

The CHAIRMAN thought it was useless to talk about building thatched cottages now, as the straw was wanted for other purposes.

Mr. TAYLOR said, The opinion which had been expressed that the grate would be constantly getting out of order, should be tested by facts. It was used at all the stations of the London, Chatham, and Dover Railway Company, and did not get out of order there. There are not more unmerciful men with fireplaces than railway porters. At any station you may see a handsome grate, and alongside it a crowbar,

and an immense piece of coal lying ready to be put on the fire. The porter puts this mass of coal on the top, reaching much higher than the bars, and then gives it sundry heavy blows with the crowbar. He never thinks of opening the register when he lights the fire, but only removes the cinders from beneath, knowing that otherwise there would be smoke on the following day. There could surely be no rougher usage than that, and yet the grate continued to act properly. His grate was not designed for burning wood.

The cost of his patent tiles for roofs was, in the case of cottages, 4*l.* 10*s.* per 1000, and the number used in a square was 185. For all other kinds of buildings—and buildings round London were being covered with them every day—the charge was 5*l.* 5*s.* per 1000. He had made a careful calculation of the cost of the materials required to build a pair of double cottages, with three bedrooms, every facing-block, every tile, every roof-course, being carefully reckoned, and he found that the total would be 40*l.* for the pair—assuming, that is, that the materials were made within a reasonable distance. If these are not near the spot the cost of the carriage by rail must be added, which is easily ascertained when the weight of the materials is known. The sum of 40*l.* did not include the concrete. He could not give an estimate of the cost of the flooring-tiles, as they had not been invented more than six months. They would, however, come to more than ordinary flooring-tiles, because they were more troublesome to make. They were made in Staffordshire, Lincolnshire, and Suffolk, and also near Southampton. Although he would supply the materials for labourers' cottages without charging any royalty, he should at the same time be benefitting himself; for when a cottage had been built with his materials, the landlord would feel that the labourer was better off than he was, and would probably give him an order for some materials for his own house.

Mr. WOOD, of Chichester, said, Understanding that the discussion was limited to the cheapness of materials, it had occurred to him that the subject of mud walls might be introduced. He happened to know that there were excellent cottages, dry and warm, built with mud walls, in Wiltshire and Suffolk. A gentleman had recently built a house near Salisbury in that way, and it was as comfortable a dwelling as any one could occupy. This had a close bearing on the cost of materials.

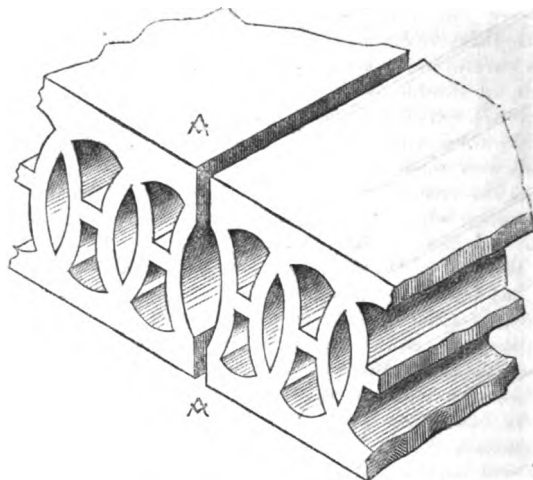
Mr. FREER said, On the estate with which he had been connected it had been the practice to build houses with what were termed clay-bats, that is, large bricks of clay and straw sun-baked. The drawback was that, in a few years, the clay-bats subsided a little; they were also more liable to injury from mice and rats than other materials.

Mr. TAYLOR thought that the remarks which had just been made with respect to mud walls, had a tendency to mislead. Such walls must necessarily be of nearly twice the substance of ordinary brick walls: they required brick foundations of twice the usual width, involving great additional expense, and every flue, every fireplace, and every chimney, must also be of brick. When they had taken into account

the comparatively small quantity of brickwork which would be avoided by the use of mud walls, had reckoned the expense of roofing the cottage 2 feet wider, and had further considered the question of durability, they would find the construction of mud cottages was most expensive.

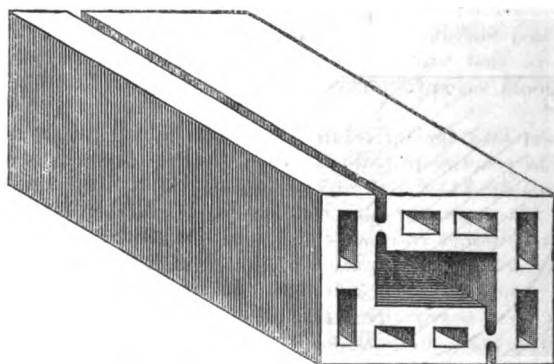
The CHAIRMAN then moved, and Col. M'DOULL seconded, a vote of thanks to Mr. Taylor, for the useful information which he had conveyed.

No. 1.



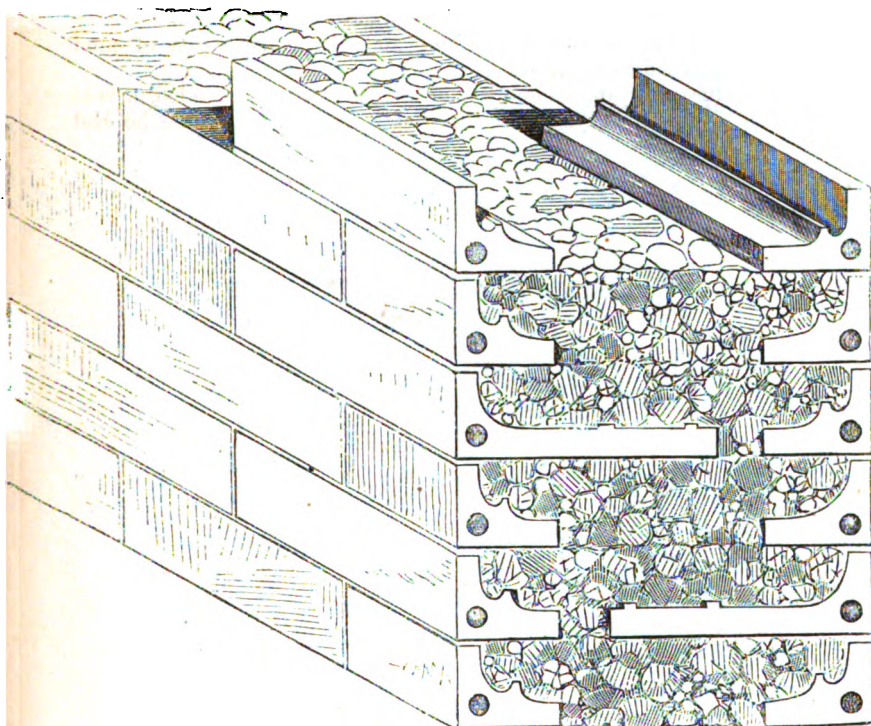
Taylor's Patent Damp-proof Course.

No. 2.



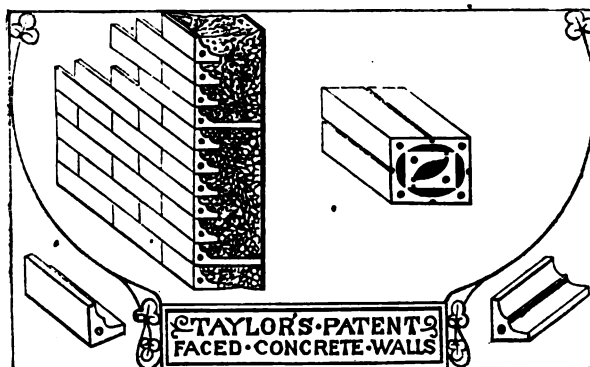
Taylor's Bricks as moulded in pairs.

No. 3.

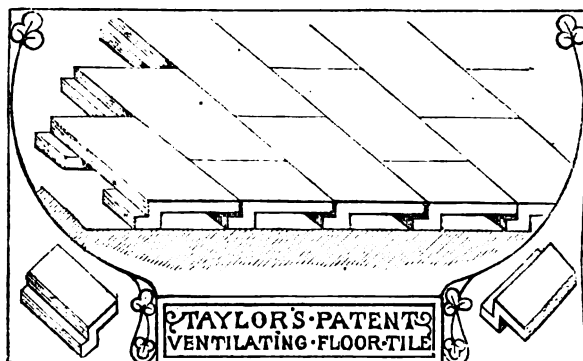


Taylor's Concrete Wall faced with Bricks.

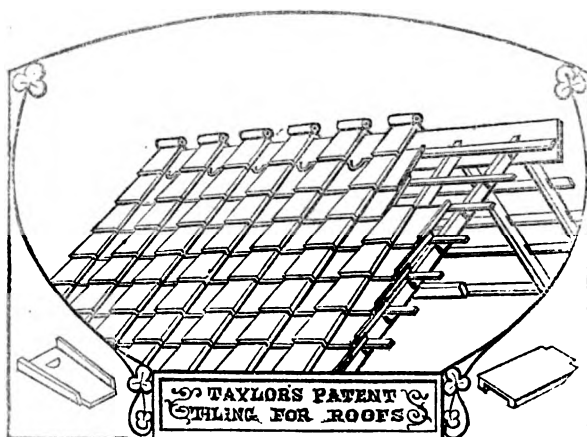
No. 4.

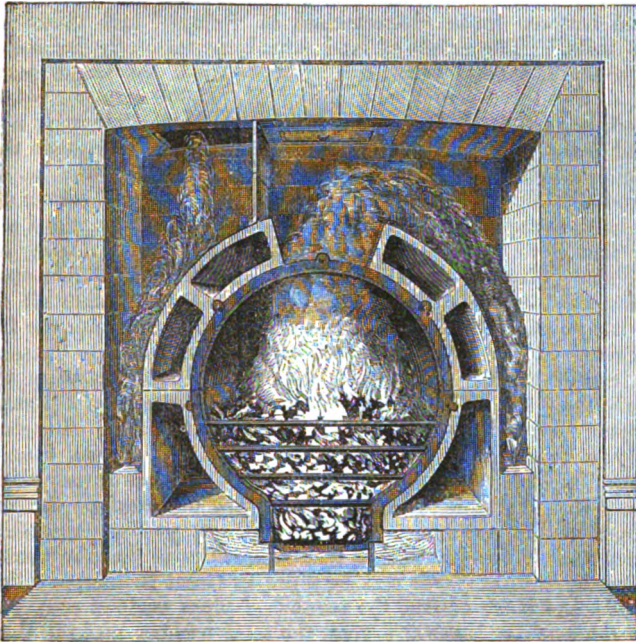


No. 5.



No. 6.





Taylor's Smoke-consuming Fireplace.

Meeting of Weekly Council, Wednesday, March 18th. Mr. RAYMOND BARKER in the Chair.

THE EFFECT OF UNDER DRAINAGE ON OUR RIVERS AND ARTERIAL CHANNELS.

MR. BAILEY DENTON said: I approach this subject with considerable distrust in my powers of doing it justice, but determined to avoid everything that may partake of a controversial and doubtful character, and to confine myself to those facts which experience and observation assure me are sound and deserving the attention of this Society. At the risk of repeating details which may be known to many, I feel it necessary for the elucidation of the matter to trace historically, in the fewest words possible, the progress of under-drainage up to the present time; and I will endeavour to do so in a manner rather to popularize than to confuse the matter by a multiplication of figures. It is necessary, however, to start with a knowledge of the magnitude of the subject; and I should state that the result of close investigation has been to show that of the total extent of Great Britain, which is

56,352,000 acres, there is believed to be 22,890,000 acres of wet land capable of improvement by drainage, including such proportion as has already been drained, and that these wet lands are nearly equally divided between those characterised as "clays" and those called "free soils." The extent of land already permanently drained does not exceed 1,700,000 acres, and of these much the larger part are clays, so that there remain upwards of 21,000,000 of acres yet to be drained, besides lands incapable of improvement. There is a very general belief that much more under-draining has been done than a careful consideration of facts corroborates. There has been so much said and written on drainage of late years, and the red colour of the pipes as they appear in the fields, like the scarlet petticoat and scarlet cloak that have become so fashionable, make such a display as we travel along, that we can readily understand how the erroneous impression has become general. Very few words will satisfy all doubt upon the point. The utmost extent of land drained under the Public and Private Moneys' Acts, and under the several Drainage Companies' Acts, cannot exceed 1,100,000 acres, as the total outlay up to the present time does not reach 6,000,000*l*. The drainage of a permanent character executed by landowners with private funds, though very largely increasing, is still much less than the extent done with borrowed capital, and at the present rate of progress it may fairly be assumed that it will take at least a century to complete the under-drainage of the country. To illustrate our present capability to proceed with under-drainage, it may be mentioned that the number of pipe-yards, or brick-yards making pipes, in Great Britain, is estimated at 2800; and if we assume the number of pipes made at each yard to be on the average 150,000 a-year, the total number made in the year may be taken at 420,000,000. The number of pipes now used in under-draining may be taken at an average of 1250 pipes per acre, and dividing the quantity made by this average we see that 336,000 acres might be drained per annum; but as a large portion of the pipes made are applied to temporary, shallow, and unconnected works, it is not possible to ascertain from such data the extent of *permanent* drainage executed. Assuming, however, that a quarter of a million of acres will, in future, be permanently drained per annum, we may see that a century will pass ere the work is completed. If such is our statistical position with respect to execution, what has been the progress and what our present state of knowledge in the science of under-drainage itself? These questions will be best answered as we proceed, and their importance will be recognised in their bearing upon the great national object of our water economy.

The first effort in the way of agricultural drainage was the raising of the surface of wet land into the form of "ridge and furrow." This may be called the aboriginal mode. The second step was the placing of bush drains under the furrows, at a depth just sufficient to conduct the water under ground, rather than along the surface of the furrow. The third step was the substitution of horse-shoe drains and pipes for bushes, still following the aboriginal furrows. The fourth step was that taken by Smith of Deanston, upon his farm near Stirling, in a

country where high-backed lands are unknown, when he adopted a uniform system of parallel under-drains, and called it "thorough drainage." To Smith must be accredited the origination of systematic drainage, but the principles upon which he advocated its adoption have been proved to be erroneous in many particulars. His object, to use his own words, was to drain "the whole of the fields without particular reference to wet and dry portions, in order to provide frequent opportunities for the water rising up from below, as well as that falling on the surface, to pass freely and completely off." In fact, Smith drained both clays and free soils alike, and was the first to lead the country wrong in this particular. He would vary the interval between the drains in accordance with the porosity of the soil; but the same depth and the same parallel arrangement would pervade every description of soil.

The next step was that of Parkes, who adhered to the parallel system of drainage advocated by Smith, but, on philosophical grounds, recommended increased depth. There can be no doubt that, by his able scientific papers, by which he traced the action of water, and explained the influence of the atmosphere on the subsoil, Mr. Parkes effected a great national benefit, and an apposite correction of the system recommended by Smith; but the parallel arrangement of drains, which, it will be seen, has been, and continues to be the cause of loss and derangement in many instances, was still advocated as suitable to all lands suffering from wetness. However irregular, and whatever the inclination of the surface of fields, and however free and mixed the subsoils, a parallel arrangement of drains was the principle advocated.

It was at this juncture, when Parkes's improvement upon Smith's system had taken hold of the agricultural mind, that the Public Monies' Drainage Act passed. The Inclosure Commissioners, who were the authorised medium for dispensing the public money, issued the best, in fact the only rules, that a limited experience suggested as consonant with the accepted views of "Parkes upon Smith." Tabulated forms became the order of the day, and the parallel arrangement of drains, seldom varying from 4 feet deep, the type of systematic under-drainage in all descriptions of soil. "The Public Monies' Drainage Act" passed in the year 1845; since which time five different companies have obtained special Acts of Parliament to supply funds to landowners as the public money became exhausted; and we now find landowners still draining their wet lands under the rules laid down seventeen years back, with all the advantage of increased experience where they are rightly applied, as in homogeneous soils and even surfaces, but with equal disadvantage where the soils are of a free and mixed character, and the surfaces irregular, corrugated, or broken. In the mean time the result has been to affect our river system prejudicially; and this evil, which is to a very considerable extent unavoidable, has been unfortunately greatly increased by the misapplication of the parallel and frequent-drain system to the free soils. To this point I propose now to address myself, premising that, as under-drainage extends to the immense area yet undrained, the

consequences will swell into large dimensions, and will render the object one of the most difficult and important engineering problems ever presented for solution.

Although the soils of Great Britain alternate so frequently, and are so much intermixed, it is still possible to classify them, so as to render intelligible the statement that the frequent parallel system applicable to one description of land is inapplicable to the other. All soils having a proportion of alumina greater than 15 per cent. may be termed clay soils, and require frequent parallel drains to overcome their peculiar retentive character. These soils cannot be aerated too much, as it is only by aëration that their retentive nature can be overcome, and their bulk rendered permeable. Soils with a less proportion than 15 per cent. of alumina admit of percolation, more rapid as the proportion becomes less, and the retentiveness, which arrests the water in the clay, is diminished. Aëration is not necessary for drainage in wet soils altogether devoid of clay, and they are therefore called "free soils." Whereas, in dense clays, you cannot put in too many drains, it is the *ne plus ultra* of drainage of free soils to reduce to a minimum the number of under-conduits by which to relieve the land of stagnant water. Test-holes decide the number with accuracy; and, wherever test-holes are the guide of operations, parallelism is the exception, and not the rule.

It is found practically, that the clay lands cannot be drained by means of test-holes. The expansive character of the soil, and the action of the atmosphere upon the sides of the test-hole, do not admit of the water passing from the test-holes to the drains with that ready response to the rainfall which is to be observed in free and mixed soils; and the recognition of this fact will confirm the classification of wet soils, by distinguishing the soils that can be drained by test-holes, and which reject uniformity of design, from those which cannot be drained by test-holes, and which require that complete aëration which is only to be gained by the reciprocal influence of one drain upon another. It is a common observation with the cultivators of heavy lands, that it is not possible to get rid of water too fast; and, in clays, this is found to be true, if the convenience of cultivation, as at present conducted, is alone considered; but, since to get rid of water with rapidity from high ground is to cause injury to the valleys below, there is some consolation to be derived from the gradual progress of steam and deep cultivation, inasmuch as the effect of deep stirring is to render fewer drains necessary to produce the required effect.

This observation, however, is altogether erroneous when applied to the free soils. All that is there necessary, under any conditions, is to set the water in motion; and the fewer the number of drains that will effect this object, the more perfect the drainage, and the better the natural powers of the soil are developed. The effect on the arterial system is explained by the fact that, in proportion to the number of drains in all soils, but in free soils particularly, will be the rapidity of the discharge, and, necessarily, the augmentation of floods below. The fact is distinctly shown by the Hinxworth experi-

ments, of which details were published in the *Journal of your Society*, vol. xx., part 2. Numerous subsequent experiments corroborate those details. By referring to the Hinkworth experiments, it will be seen that, on the occasion of a fall of rain of half-an-inch (January 10, 1857), the flow of water from the under-drains was increased from 910 gallons per acre (which was the flow on the 9th) to 2420 gallons; while in the clay lands, which had been considered to be impermeable, the discharge was increased from 125 gallons per acre to 5150 gallons on the same dates. This difference is to be accounted for by the fact that the distance between the occasional drains in the free soil had been increased, by the guide of test-holes, to 58 yards, while the distance between the parallel drains of the clay soils was only 8½ yards. In each case, the land had been equally wet, and was equally well-drained. To realise the effect of close parallel drainage of the clay lands on the arterial channels of the country, we must remember that the extent of clay lands not drained, and yet to be drained, is 9,000,000 of acres. These 9,000,000 of acres are dispersed all over the country; and the quantity of land that might be placed under water, by default of outfall (say 10 inches deep), were the full extent drained, would be upwards of 200,000 acres. Before draining, it is possible that the same quantity of water might have found its way over the saturated surface, and have been lodged in the hollows and ditches for gradual passage to the outfalls; now it is no sooner discharged than it is delivered by improved tributary water-courses into the main valleys to collect there for want of sufficient outfall to the sea.

The free soils form a proportion of more than half of the lands still requiring drainage; they are estimated at 12,000,000 of acres. They consist of a very large proportion of the wet land of the West of England, of Wales, and of the North of England and Scotland. The Devonian, the Silurian, and Cumbrian districts are of this character, and the saturated beds of the old red sandstone, the new red sandstone, the Bagshot sand, and the various drift superficial deposits, may also be so classified. If critically examined it will be found that the wet soils of these formations consist either of the *débris* from higher land, saturated with the water of pressure sinking from the heights into the lower valleys, or from the water having travelled through a wide region of a free stratum to the surface where that stratum outcrops. To appreciate the advantage of draining the free soils by the fewest number of drains (indicated by test holes), that will set the water in motion, and lower the water level beyond the reach of active evaporation, we should have regard to the important fact that they suffer by reason of their formation and position from an excess of water beyond that which falls in the shape of rain upon them, and they are therefore immense stores from which we should draw with care and economy. It seems unnecessary to say that whatever passes through the drains into the rivers cannot escape into the air by evaporation; and that whatever the amount of water may be so arrested from the atmosphere, is a gain to the rivers in one shape or another. But it does not follow that this discharge augments

the floods; on the contrary if free soils are properly drained—with no more drains than are necessary, as has been explained—their surfaces instead of being saturated are in an absorbent condition, and capable of taking in and storing the rain that falls upon it. This they will gradually discharge by the few appropriate drains adopted; and by such means floods may be reduced, instead of being increased, as is the case by the too generally adopted treatment of frequent parallel drainage. It has been stated that drainage does not diminish evaporation; but reflection and the observation of facts must dispel such a notion. It is undeniable that the water discharged from the drains must be removed from the action of evaporation on the surface of the land; and inasmuch as the drains commence to run, and only can run continuously, when the water level in the ground has risen to the height of the drains, it is clear that those drains are always arresting, in some degree, the upward action of the water toward the surface of the land from which it would be evaporated. Numerous experiments clearly demonstrate that directly the water on the soil rises to the level of the drains, the drains begin to discharge, and that were it not for those drains, the water which finds vent at the drains would gradually rise to the surface, and from thence pass off as vapour into the air. This fact, while it goes far to show that evaporation from free soils must be diminished by the drainage, at once disproves the statement, so often repeated, that the extent or period of drought is increased. These latter remarks apply merely to free soils.

We know that the drains in clay soils do not discharge until the body of soil from drain to surface has in its grasp sufficient water to fill it to the extent of its retentive powers; and it can be well understood that evaporation, fed by capillary attraction, will be as great as before, so long as the soil is in that state of repletion, although the land be drained. In free soils there is no retentive quality to maintain, nor is capillary attraction sufficiently active after drainage to raise the water from the level of the drains and uphold it at the surface of the ground.* Thus we see that not only in the action of water through the land, but in the hygrometric influence of the atmosphere, the two descriptions of soils are differently affected, and it becomes manifest that to apply the same principles of drainage to both is a compound fallacy; a fallacy *quod* under-drainage in its effect upon land-owners individually, and a fallacy *quod* arterial drainage in the effect upon the water economy of the country generally.

It is not long since I had the pleasure of reading a paper before the Institution of Civil Engineers, having the same object as the

* The amount of evaporation from a constantly saturated surface, like some of our stagnant valleys or pent-up bogs, has never been ascertained; but some interesting experiments were made by the late Mr. Charnock of Ferrybridge, and printed in the Society's Journal (vol. x. p. 516). They were confined, however, to the limited surface of a gauge filled with soil, and showed that whereas the evaporation from a constantly-saturated surface, maintained in that condition, was 8 in. more than the rainfall, that from a drained soil was 5 in. less than the rainfall. These experiments are not sufficiently confirmed to be taken as a guide for the evaporation from a natural surface.

present paper, in order that I might attract the attention of the highest practical authorities to the subject; and there was only one opinion expressed upon the effect of under-drainage on the arterial system: which was, that the floods were more quickly precipitated into the valleys, in proportion to the extent of under-drainage in the various river basins, and that the continuance of flood depended upon the capability of the main outfall. Reference was particularly made to valleys into which the tributary water-courses had been opened for the outlet of upland drainage water, and it was stated that heavy rainfalls now produce a flood in two days, whereas it formerly took a week or more to do the same thing. The question whether under-drainage increases the volume of flood waters was not discussed, though the prevailing impression was, that—contrary to the theory of drainage, which would lead to the expectation that the rain would pass through the drained soil less rapidly than it had hitherto passed off the saturated surface—the quantity discharged at flood times was not diminished. In a paper now under discussion at the same Institution, by the Rev. J. C. Clutterbuck, it is stated as the result of a general inquiry into the peculiarities of the Thames basin, that the floods are advanced twenty-four hours in seventy-two hours within the last twenty years. That the hastening of floods, not so much from any positive increase in the quantity of water, but from its concentration, is the general effect of under-drainage, I do not think any one will deny, nor that in proportion to the number of under-drains will be the suddenness with which the discharge is effected from the land into the tributary channels. Doubt was expressed by several eminent engineers whether the effect of under-drainage of the free soils could possibly increase the perennial supply of water to the rivers; but as the subject was new to the Institution in the light in which it was introduced (*viz.*, by separating the retentive soils from the percolative, water-bearing soils, and showing that the two are susceptible of distinctly different treatment and results), I was not surprised to find an indisposition to confirm the deductions to which my experience had brought me; and I attributed this to the circumstance that the free soils have hitherto for the most part been drained in the same way as the clays, and have rather increased the evil of sudden flood than been made the means of regulating and of improving the supply in summer. So important do I deem it that this view of the question should be well understood, that I venture to exhibit the plans of two works of free-soil drainage which have been carried out. One is in Wales, in the Silurian district, and the other is in the South of England, on the Bagshot sand formation. In both cases parallel drainage was originally intended by the owners, though their intentions gave way to occasional or test-hole drainage. In the first instance a contract was entered into in accordance with the plan A, and fortunately abandoned, by which a parallel system of one uniform depth and interval was to be carried out, and the number of rods per acre would have been 132, and the cost 1*l.* 10*s.* per acre. If that drainage had been adopted, there is little doubt but that some benefit would have been derived. The numerous drains would have pre-

vented wetness showing itself at the surface; but it is doubtful, as the land is generally mown, whether the herbage would have been so profitable as that produced from less frequent drains, while the river would have suffered from flood on every occasion of heavy rainfall. This mode of drainage was not, however, carried out; but the system exhibited on plan B was adopted. In lieu of 132 rods of drains only 34 rods were put in, and instead of being of uniform depth, they varied in depth from 5 to 8 feet, and were more expensive in character per rod. The result of this drainage has most decidedly been a considerable saving in cost, the creation of a constant supply of water to the river in summer, the lessening of sudden floods in winter and spring, and the maintenance of a greater amount of moisture in the ground itself, without stagnation within it. The second case is very similar in the circumstances attending it as exhibited in Plan C. Both were drained by test-holes; and in order to explain the *modus operandi*, one of the monthly returns of the foremen conducting the works accompanies each plan, from which it will be observed how closely the water in the test-holes rises and falls in accordance with the rainfall. So fully saturated was the soil, that while the test-holes were open, before the drainage began, the cattle in the fields used to drink from them.

The same mode of drainage has been adopted on the Ribstone Estate in Yorkshire, where a gentleman here present has watched with great care the progress of the work, and can speak to its effect. I refer to Mr. Dent Dent, M.P., who will, I have no doubt, corroborate the statement that a very different mode of operating had been designed from that adopted of a wide and occasional system of drainage, based upon good outfalls, and carried out as deep as those outfalls would admit. At the present moment this drainage is being carried out by test-holes, which regulate the number of drains to be put in. A monthly return of the rainfall and heights of water in the test-holes (of the same month, February, as in the previous cases, but in the present year, instead of 1862) is shown on the walls. It is not exaggerating the case to say that less than one-third the number of drains are now adopted than would formerly have been used, and with better effect, and necessarily at less cost. Were this illustration only made to advance a particular engineer's practice, it would be unworthy of your consideration; but when it is shown that the adoption of the test-hole system not only secures an effective and economical drainage of the saturated free soils, of which Ribston is the type, but necessarily leads to less suddenness of floods, and sometimes to a constant flow of water when it is wanted, I think you will consider that it is the duty of any one interested in this subject to place it prominently before the country. Previously to the adoption of this system at Ribston, the parallel system was in vogue; and on an adjoining estate with similar soil, it is now in operation with a far different effect upon the question of our water economy.

It will be asked, "To what practical end do these observations lead?" The reply is soon given. It is admitted (as proved by experience) that the drainage of wet lands is the basis of good cultivation,

and a means of individual and national wealth, and that it will proceed, let the consequences be what they may. It is admitted, too, that, as under-draining extends, it must be concentrated in the valleys for discharge by the main outfalls to the sea. The reply, then, is made manifest. It becomes the duty of the country to provide for sudden floods by improving the outfalls and dealing with the rivers systematically from the seaboard to their source. The Land Drainage Act of 1861 is a good basis upon which to form districts for the improvements of valleys and outfalls, and for the conservation of drainage-waters discharged in the spring for use during periods of drought, in those districts which suffer in the summer season. But there is the other point to which I have made particular reference, and which I consider of equal importance to the landed interest—I mean the proper mode of under-draining the different descriptions of wet lands. The mode and results of draining the clay soils are fully understood, and but little advantage is to be gained by discussion. It is the drainage of the free soils to which attention is due, and which cannot be too much discussed, for with them it is possible to moderate the evil of sudden discharge, and, instead of committing injury, to improve, by their appropriate drainage, the water supply of the country. It is a custom to designate systematic drainage a scientific operation; and, of all misapplications of terms, it is impossible to conceive anything so inappropriate as to call the drainage of free soils by a parallel system a scientific work. So directly is it the reverse of science, that, fifty years hence, our children will look upon it as an absurdity as great as the adoption of under-drains 18 inches deep is now regarded by those who are draining 4 feet, and more, deep. In truth, up to this time the engineering element has been entirely absent from the under-drainage of land. Equidistant parallel drainage is not science, though it required the scientific writing of Parkes to render adequate depth acceptable.

But, while care and diligence alone are requisite in the clay soils, the best judgment and skill are required in the drainage of free soils. Frequently the source of evil is far from the land we are about to drain, and the quantity of water to be removed many times the quantity that falls on its surface. It will be received, perhaps, as an indication of a want of knowledge on my part if I say that, in the drainage of free soils, the criterion of sufficiency applicable to the clays does in no way apply. If water stands above the pipes after draining the clays, it is quite certain the drainage is not right; but, if the water stands above the pipes in free soils, and the quantity of water discharged from the outlet is in excess of that which falls on the surface, the drainage is doing its work, whether the water be above the pipes or not.

Careful observations upon the rise and fall of water in a free soil have exhibited some extraordinary phenomena, which, in the majority of works, as now conducted, are disregarded. In several districts in which I am now operating, and in which I am keeping a record of the rainfall on the surface, the discharge of water from the drains, and the rise and fall of water in the test-holes, I am gathering information of the most valuable character. I may mention, as an instance, a case in

which the outlets have been for some months discharging from a few drains adapted for the drainage of a large area, as much as 3 inches of water over the whole superficies per diem, although but little rain has fallen on the surface for a considerable period. In this case the water stands above the pipes. In the month of June this water will decline to their level. A superficial observer would declare the land not drained, though the effect of the drainage has been to discharge in the last month (February) more than twice the average quantity of water that falls annually on the surface. Again, such is the porosity of certain districts, that 1*l.* well spent in securing a deep and effective outfall, is equal to many pounds spent in shallow and frequent under-drains, although the outfall is not sufficient of itself to effect a cure without subordinate under-drains, few and far between. A curious instance, illustrative of the peculiar character of free soils, occurred upon the Ribstone Estate. On the occasion of a recent flood the open outfall cuts were filled with water, and one field was observed to be in a very wet and quaggy state; so rotten, in fact, that it was hardly possible to walk across the field. The drainage was for the moment considered defective, although the test-holes had responded satisfactorily to the drains that were put in. When the outlet was visited the water was found many feet above it, on a level with the land itself, and an index well within the field was found to be full of water up to the brim. Within a week of this observation the waters in the outfalls had receded, the outlet and well became clear, and the soil became as firm as ever. Thus we see that the whole of the field had been re-saturated by water from the outfall permeating its whole mass; and that as quickly as it penetrated, so it receded when the outfalls were clear. This field ten years ago would have been drained on the parallel system! Numberless instances could I give to show that more comprehensive views are suited to free and mixed soils, if we are to drain them consistently with their properties, and with due regard to the water economy of the country; but I abstain from multiplying them. It is not long since successful efforts were made to regulate the salmon fishing of our streams, and legislative powers were sought and obtained; but then private interests were at stake. Here the matter is a general one, and I fear few will be found to take any prominent lead in initiating measures which shall lead to river reform. The more numerous the evils, and more difficult the means of overcoming them, the less likely are we to have immediate remedies. In the matter of our rivers, the injury we are suffering is progressive and accumulative; they are not limited to the increase of floods, but extend to the contamination of the water, for many towns are discharging their sewage into streams previously pure. But until the floods have increased, so as to involve the loss of life; until the waste that has been occasioned by the inappropriate drainage of free soils has told its own story; and until our rivers are made insufferably foul, we shall find no remedy. As one who has been interested from its infancy in drainage as a system, and who from active employment up to the present time has become acquainted practically with existing defects, I shall not be reproached with placing myself unduly promi-

ment in forewarning this Society of approaching evils, and leaving the matter there. I feel I cannot do better than close this paper with a passage I wrote more than twenty years ago, when struggling to obtain the first Act which founded the Drainage Commission. It is this: "If it is thought fit that each owner and occupier of land should add their proportionate quota to our wealth as an agricultural nation by the application of science to their calling, then it is not only equitable, but it is imperatively necessary, that a general law should be laid down for the clearing and maintenance of outfalls, and that a systematic order should be adopted with a due regard to the water of drainage as discharged. We have seen the evil of disorganisation in the sewerage of towns, and we are about to apply a remedy. No better result will follow the operation of any partial system for draining land: apathy will prevail in some cases, prejudice in others; and as each district, when drained, will be independent of surrounding ones, a medley of works, as specific in themselves as dissimilar in construction, will start, in defiance of order and contempt of system, into inefficient existence." This is precisely our present position.

Mr. DENT, M.P., said allusion having been made by Mr. Denton to the works which were being carried on upon his father's estate, he wished to say a few words respecting them. Those works had only been in progress since this time last year, and therefore there had scarcely been time to judge what was likely to be the effect. The district was a very wet one, and a very unpleasant district to ride over. It consisted of an immense variety of soils. There were under drainage about 35 acres of grass land, of a strong, tenacious character. In other fields there were soils running from quicksands into clays, with a considerable quantity of stone. Since his father bought the estate he had drained to a considerable extent, and found in the soil a number of stone drains of older date at good depth, which were always full of water, having no proper outlets. During the last ten years he had himself drained a great deal, generally on the parallel system; but he was unable to go as deep as he should like to have done, because the outfalls of the natural brook running into the river Nidd were not adequate. The first work of the Drainage Company was to enlarge these outfalls, and this enlargement had had a considerable effect on the neighbouring soil, drying test-holes at a distance of 40 or 50 yards. The particular field to which Mr. Denton alluded he had just taken into his own hands. Part of it had been for two years fallow, because the tenant thought it hardly worth while to grow a crop. It was drained upon Mr. Denton's system, with test-holes. He watched the drains, which were placed at various depths, very carefully. At first they seemed to work satisfactorily; but when heavy rains came in January, in walking over the field he found it as bad as ever. Mr. Denton came down to inspect the works at a time when there was a very heavy flood; and when he saw the state of the field, he did not seem at all comfortable. That gentleman's statement as to the rapidity with which the river rose and fell was quite correct. One day the water in the outfall would be 6 feet deep, and a few hours after not 6 inches. This field was sown with wheat, and on the 3rd of

February, soon after a heavy rainfall, hounds ran across it; and in riding over it himself he was delighted to find that it was quite sound. The other day he received a letter from his bailiff, who stated that he had not found the wheat at all damaged.

He wished now to put a question to Mr. Denton. During the last fortnight he had been staying in a part of Middlesex where he was very much struck with the state of the grass lands. He had always supposed that there was no county where more or better hay was grown than in the neighbourhood of London; but he now considered it perfectly marvellous how anything at all could be grown, so saturated was the land with water. He was told that all the farmers who were great hay-growers said that it was of no use to drain the land deep; that, if they drained deep, the land baked, or caked, so much in the dry season, that all its grass-bearing powers were completely destroyed. He should like to hear what Mr. Denton had to say on that point.

As regarded the constant supply of water to be obtained from the system of drainage which had been described, he would say that his own experience did not support that view. Some of his drains cut last year, which yielded a great deal of water at first, had since very nearly run themselves dry. Mr. Denton's idea seemed to be that there was a kind of perennial supply from drains of that nature. Whether that was so or not in other cases than his own he could not say. In his own case they were now putting in not more than a third of the number of drains that they did before; and, considering the way in which the drains dried the test-holes, he was inclined to think that even now they were put too closely, especially for grass land. Their depth was not less than 4 feet. In the clay land none of the drains were more than 4 feet deep, and they were 8 or 9 yards apart. As to the drainage of porous or free soils, Mr. Denton was undoubtedly right in principle. What would be the effect of deep drainage in the case of strong clay soils, was a matter on which he felt some doubt.

Mr. HOLLAND said he had a most difficult clay to deal with. It was what Mr. Denton called a corrugated soil, and draining could only be done by a very slow process indeed, the subsoil itself being more or less corrugated. In draining they were compelled to follow the direction of the furrows, which, as the result of continual ploughing for ages, were very frequently in the shape of the letter S; still they did drain, and drain deeply. The furrows were in some cases 40 or 50 feet apart, and drainage at such an interval on clay soils is necessarily imperfect. Fortunately, however, deep cultivation, and more particularly steam ploughing, enabled them to bring down the elevations in the land more rapidly than it could possibly be done by horse-power, and by degrees they were making the land perfectly flat. When the cultivators of the soil had thus been enabled to level all that their ancestors were so careful in raising, the drainage might be perfected by the introduction of an intervening drain. He had tried, for the sake of experiment, the effect of draining about 6 acres in straight lines, without regard to the ridge or furrow: it was a complete failure. He did it with great care, going deeper than he should

otherwise have done, from the inequalities of the surface; but with all this the result was a failure, and he was obliged to drain the whole over again. The depth of his drains was generally 4 feet, and there are many furrows where you can only see the head of a man in the next furrow.

Mr. B. DENTON, in reply to Mr. Dent's remarks respecting the state of Middlesex, stated that last week he went—not for the first time—over a large estate in the neighbourhood of Harrow, belonging to Lord Northwick. He was accompanied by his Lordship, and the question which Mr. Dent had raised was discussed. They inquired of the occupiers why there was a disinclination to drain. The answer given was that it would lessen the quantity of grass—the very thing which they most wished to avoid. They had a good customer, they said, in the London market, for any hay, let it be ever so bad, which they sent there, and therefore quantity was what they aimed at, and not quality (Hear, hear). Now, he really thought that this was a complete answer to Mr. Dent's question with respect to the drainage of Middlesex. He should add, however, that on Lord Northwick's estate there were two or three very intelligent tenants, who declared that the present system was a bad one, which they were altering, and intended to alter still further. For the future the land would not be devoted to hay-growing only, but fed in part, and mowed in part; that the moment the cattle's mouth reached the ground, draining was found to be very beneficial in the sweetening of the herbage; but that draining did not increase the quantity of grass, and therefore if they were dependent on the sale of hay, it would not answer their purpose.

He was very anxious that his views with respect to the draining of porous land should not be misunderstood; and he wished particularly to tell Mr. Dent that as regarded flat districts he did not anticipate that there would be a perennial supply of water, though it would not surprise him if that should be the case. But in those hilly, mountainous districts of the West and North, when the major portions were high, with valleys interposing, the low grounds were filled with the *débris* of the high lands, and were maintained in a constant state of saturation during summer by pressure; in such cases under-drainings would create and maintain a constant flow. It should be borne in mind that every inch of rain-falling on the surface gave 100 tons per acre; and if the discharge of the under-drains was equal to 40 inches of water over the whole area under-drained—which is not at all uncommon in draining the low grounds of hilly districts—the quantity discharged would be 4000 tons per acre.

Considering the quantity of water which under-draining removes from the reach of evaporation, and the quantity which must be constantly filtering through the soil from the higher to the lower level in hilly districts, it is clear that draining must frequently originate a supply, by affording a vent for the water of pressure.

The CHAIRMAN said, living as he did on the banks of the Thames, he was in hopes that they would hear more about the influence of drainage on rivers. He well remembered the floods of 1809, and other great inundations to the west of London. In the neighbourhood

of Reading and Henley the water had remained on the ground for a fortnight, and even three weeks; the case was still worse at Oxford; but this winter there had been scarcely three days' flood lying on any portion of the flat.

Mr. B. DENTON said, the subject to which the Chairman alluded was under discussion the previous night at the Institution of Civil Engineers. It was introduced by Mr. Clutterbuck, and underwent a good deal of consideration. It seemed to be the general opinion, that in the alternation of soils from the close clays to the open beds of oolite and other strata, the water which travelled over the clay was lost in the porous beds, and that it was not possible, from any data now existing, to give in volume the result of what soaked in, and of what travelled over the different beds.

Professor SIMONDS said, as he happened to be himself the occupier of a tolerably large hay-farm near London, and contiguous to the land to which Mr. Denton had referred, he should perhaps be able to throw some light on the prejudice which prevailed, as he thought very unjustly, against under-draining in that neighbourhood. It is well known that from the Harrow district London obtains a large portion of its hay; and many suppose that Middlesex farming is carried on under very favourable circumstances for deriving a large return for the capital employed. All he could say on that point was, that he believed that a man who occupied a *hay-farm exclusively* near London would very soon find himself in the 'Gazette.' There was no profit to be obtained from hay-farming in the neighbourhood of London. This was evident from the quantity of hay which the farms yielded on the average of a number of years, and the expenses attending the making and sending it to market. It might, he thought, be assumed that the average rent in the Harrow district was 50s. per acre; and haymaking, even in a fine season, with all the appliances of machinery, mowing-machines, tedding-machines, hay-collectors, horse-rakes, &c., had never cost him less than 22s. or 23s. per acre. In addition to these two items, there was at least a shilling per load for thatching. Thus, if a stack contained 60 loads, it would cost 3l. for straw and labour to have it thatched. Again, there was 2s. 6d. a load for trussing for market, and 4s. a load commission for selling. There was, further, the cost of the man's labour in carting the hay to the London market. He was gone a whole day, with a cart and two horses, which also involved additional expense. The result of all this was, that a load of hay could not be sent to market at an outlay of less than 4l.; so that, if the farmer got no more than 4l. back from the salesman, he would have nothing in pocket. The only advantage that could be looked for was in drawing more than a load of hay per acre; and hence, as Mr. Bailey Denton remarked, it was the supposed importance of getting quantity rather than quality that made hay-farmers opposed to draining. Another thing which militated against the growth of good grasses in the district in question was, that the present system of making hay had been in operation for so many years, that it thoroughly impoverished the farms. Suppose a man mowed 200 acres of land, and got from it on an average—which he certainly

did not—a load and a half per acre for the London market, that would of course give him 300 loads of hay. It would occupy just a year to take the hay to market, reckoning the cartage at a load per day. If two loads per market-day were carted that would make no difference in the result. Suppose further that a load of manure per day were taken back from London, that would be 300 loads in the course of the year; and, assuming that the manure is put on the land directly it arrived (which every practical farmer knew could not be done) at the rate of 10 loads per acre, 30 acres of land would be manured in the year. Thus it would require seven times the quantity that was taken away to manure the whole 200 acres; and though a particular field near the road might look very well, much of the land near it must be in a sad condition. Such was the result of growing water-grasses. Let the water, however, be got out of the soil, and artificial manure applied to the grass, and a great improvement would soon be visible. He was speaking from experience, having under-drained some of his meadowland, and dressed it first with farmyard manure, and afterwards with artificial manure. He could affirm, that not only was the quality of the hay considerably improved, but that he got not a pound less than he did previously. The Middlesex farmers admitted the advantage of under-draining in reference to feeding. They said that if they fed stock they would benefit by draining, in the quality of the beef and mutton made on the farm. But many of them could not purchase a sufficient number of cattle and sheep, and hence they persisted in the impoverishing system of producing hay almost solely for the London market. If they would use one half of the land for hay-making and the other half for feeding, they would, he believed, soon be in a much better position. What was the consequence of the undrained condition of the land in relation to stock? Why, that they saw there the worst possible cattle to be found in England and the worst possible kind of sheep. This arose from the circumstance that the occupiers had a large quantity of grasses which they wanted to clear off in the autumn. Many of them could not afford to buy sheep to feed off the land. What did they fall back upon? The breeding of lambs from Welsh ewes. They put a number of these ewes in winter to Leicester tups; they lost many of the animals during the winter months, and in the end they did not find the amount of profit which they had expected. He believed that if the Harrow district were thoroughly under-drained, not only would the farmers have a better quality of hay, but the quantity would not be at all diminished, provided the land were under good management (Hear, hear).

Mr. FREE said the names of Mr. Parkes and Mr. Smith of Deanston, to whom the public were so much indebted for the parallel system, had been very properly mentioned by Mr. Denton; but there was another name which certainly ought not to be forgotten in a discussion relating to the draining of porous soils; that of Mr. Elkington. He had arrived at one conclusion from recent inquiries into the drainage of other countries, especially of Italy, namely, that partial and incomplete works for the removal of water very much

embarrassed the execution, and added to the expense, of later works undertaken in a more comprehensive spirit. Anxious as he was, therefore, that this great subject should be taken up everywhere in England, he thought nothing could ultimately be more prejudicial than that partial and ineffectual attempts should be made, rather than the day waited for when comprehensive plans might be wisely undertaken.

Sir JOHN JOHNSTONE, M.P., in moving a vote of thanks to Mr. Bailey Denton, expressed his concurrence with most of his views on draining free soils, and his satisfaction that that gentleman's valuable services had been extended to Yorkshire. He had ridden over Mr. Dent's property; he knew perfectly well what had been the condition of some of the fields, and he hoped that when he next rode over the estate the horses would not labour so much. Everybody in Yorkshire was disposed to do justice to Mr. Parkes in connection with the parallel draining of clay soils; but Mr. Parkes, like many other gentlemen, thought that parallel drains might be placed in the Vale of York 80 or 40 feet apart, and the consequence had been that many persons had been compelled to put intermediate drains in order to make the drainage effectual. What was said by Mr. Denton with respect to the effect of drainage on rivers was well worthy of attention. In Yorkshire, mills had in many cases been taken down and steam-power substituted for them. He agreed with Mr. Denton that England could never be effectually drained unless some great public works were undertaken for the purpose of improving the outfalls of the rivers towards the sea. The loops in the streams were in some places so complicated that the water could not get away, and hence he believed in some cases the land was in a worse state under deep drainage than it ever was before.

Mr. FISHER HOBBS said, As a director of a land drainage company which had the able assistance of his friend Mr. Denton, he had purposely abstained from following that gentleman in his remarks, in most of which he agreed, especially those with regard to porous soils. He thought that the report of that meeting would be of great service as regarded drainage generally. The landlords generally did not appear to be aware how desirable it was to adopt different systems of drainage according to the varying character of the soil. Upon his own property he had adopted the system which was so well carried out many years back by the late Mr. Elkington, and was glad that name had been mentioned, because he thought that if they were to carry out the Elkington system more than they did in tapping springs, adding the test-holes to which Mr. Denton alluded, porous soils would be drained more effectually and at less expense.

Mr. WELLS, of Redleaf, Kent, said he wished to ask Mr. Bailey Denton whether the Government Inspectors, who now inspected so much of the drainage of the country, allowed persons discretion as to draining as they were advised, or whether they did not, on the contrary, impose stringent regulations?

Mr. BAILEY DENTON said, As he acted very much under inspection,

that was perhaps the most delicate question that could be put to him ; and if he abstained from touching that matter, it was from no want of respect for the gentleman who put the question, but from some little respect for his own position.

Meeting of Weekly Council, Wednesday, April 15. Mr. RAYMOND BARKER in the Chair.

THE ADULTERATION OF OILCAKES.

PROFESSOR VOELCKER said : The subject on which it is my privilege to-day to address the members of the Society is one of especial importance at the present time, when not only oil-cakes, but all kinds of feeding mixtures are more and more employed by the British farmer for the fattening of his cattle. This great increase in the demand for feeding materials has led to adulteration with matter sometimes downright injurious to health, at other times with those that possess no feeding properties, or with substances which, at the best, are of a doubtful character. The great demand for all kinds of oilcake, more especially the great demand for linseed-cake, has led to an amount of adulteration of which the practical farmer is hardly aware. Anyone who takes a survey of the stalls in our large markets, and looks at the various kinds of cakes, cannot fail to be struck with the very great variations which their appearance presents, whereas in the seed no such difference is manifested.

I have here before me samples of linseed which comes from various parts of the world ; but they do not differ much in colour. When, then, we find one cake nearly as white as a poppy-cake, another very dark, and another, like the American barrel-cake, possessing the nice colour of linseed itself, we have here good *prima facie* evidence that the light cake is probably mixed with white-poppy cake, the dark-coloured with rapeseed, and that the third is in all probability the pure linseed-cake. The very appearance of the cakes, then, as they are sold in our markets, affords sufficient evidence that something or other is done with the linseed besides pressing it for oil, which must have some influence on the quality of the cake. Now, if oil-crushers would merely confine themselves to such admixtures, perhaps the injury which is done by inferior descriptions of cake would not be so great as it is in reality. The farmer would simply pay for an inferior cake like rapeseed the proper price for cake of the best description. But in many instances in which the farmer buys cakes he buys in reality mixtures which are more or less injurious.

I shall first direct your attention to those admixtures which are in themselves injurious, and secondly to those which become injurious during the time of keeping the cake. There are also matters added to oilcakes which deteriorate the quality of the meat produced, by imparting to it a bad flavour, so as to lower its market value. Let me first point out what are the characters of genuine or pure linseed-cake. A good

pure linseed-cake ought to be made of nothing but pure linseed—practically-speaking pure, not absolutely pure; for such seed is not to be found in the market. The condition of linseed as imported varies in reality to an enormous extent. Many oilcake dealers guarantee their cake as genuine, made from genuine seed as imported; but this is really no guarantee whatever. I have here a sample of linseed in which there is a large amount of impurity in the shape of various kinds of other seeds. Here is another not very pure; and a third that is extremely impure. This is considered of middling quality, containing as it does not less than $34\frac{1}{2}$ per cent. of foreign seeds—that is, seeds that are not linseed. Well, a cake made of this seed may be genuine, or made of seed “genuine as imported,” but it is certainly not a pure cake, and the manufacturer who stamps such a cake as pure does not deal honestly with his customers. True, he might find a loophole in terming it genuine linseed; because the question might be raised what is genuine linseed; but when cake is termed “pure,” it ought to be made of seed which, like many samples of linseed, more especially the Bombay linseed, some of the Alexandrian, or the better descriptions of Petersburg linseed, contains, comparatively speaking, a trifling quantity of foreign seeds; and when a cake is made of very dirty linseed, it certainly cannot be called pure linseed.

A mere inspection of this sample will show that it is in reality a good pure linseed: it bears not its stamp in vain; whereas, this other, which is likewise stamped “pure,” exhibits such a large proportion of other seeds, that you will find at once it cannot be a pure cake. I have taken the trouble to procure specimens of linseed from various quarters, more especially from Hull, for examination; and as it may be interesting to the members of the Society to have some idea of the proportions of impurities which they contain, I will read the list. Bombay linseed, in one sample, gives $4\frac{1}{2}$ per cent.; the finest Bombay that ever came under my notice contained $1\frac{1}{2}$ or barely 2 per cent. Black Sea linseed, 20 per cent.; a second sample, 12 per cent. Odessa linseed, $12\frac{1}{2}$ per cent.; medium Riga seed, 35 per cent.; Morshanski linseed, 7 per cent. Fine Black Sea, imported December, 1861, and sold as fine Black Sea, 19 per cent. Another sample, landed in 1862, and considered of good average quality, also contained 19 per cent. Fine Petersburg, $3\frac{1}{2}$ per cent.; Petersburg Rijeff (common), 41 per cent.; a second quality $43\frac{1}{2}$ per cent. Riga crushing, consisting of average quality, and shipped from that port, $49\frac{1}{2}$ per cent.; another sample, imported 1862, 42 per cent. Petersburg Rijeff (common), of which a large quantity finds its way to Hull and other ports, 70 per cent. So that there are actually samples of linseed sold which contain only 30 per cent. of pure linseed and 70 per cent. of impurities. Now no one who looks over this list, and these are samples taken indiscriminately, can help being astonished at the amount of impurities which are contained in seed “genuine as imported.” The fact is, that the seed frequently gets adulterated before it is landed in England. As soon as it reaches the hands of the Greek merchants it undergoes the adulterating process. Fine

samples are made and sold to a few firms that make pure linseed-cake, and have good customers who can afford to pay a proper price. The impurities are sifted out and made into second, third, and fourth qualities, which then are sold under various names.

Now, if the seeds that occur in linseed were all of an indifferent quality, that is to say of a character not injurious to life, the injury would not be so great, but some of them are poisonous. From several samples of linseed I have separated the seeds and ascertained their botanical characters. In one particular sample I counted not less than 29 different kinds of weed-seeds, and among them the following which are more or less injurious: The common dandel, which is frequently present in considerable quantities in the inferior samples of Petersburg seed; corn-cockle, which often produces very serious effects on the animal system; wild radish, which occurs in some samples of Alexandrian seeds, and is very pungent; wild rape, which is not, properly speaking, a rape, but rather a mustard; charlock, or the common wild mustard. All these are seeds which it is positively known are injurious to the health of animals. But there are others which, as I stated at the beginning, impart a disagreeable taste to the meat of cattle fed upon inferior cakes. The Gold of Pleasure, or *Camelina sativa*, is such a seed, giving a disagreeable taste and also a deep yellow colour to the fat of animals. From the appearance of *Camelina* cake, you would think it ought to be nutritious; but it is an inferior description of cake, because it deteriorates the quality of the meat. Another seed of an injurious character is the purging flax.

Now, a good and genuine linseed-cake ought to have a bright colour, and when mixed with water ought to form a thick, agreeable-tasting, and pleasant-smelling jelly; but a very disagreeable smell is developed, if you mix with water an inferior cake, like that of a cago in which you keep canary-birds. This is due to the impurities of the seeds. Among others, the common spurry and hempseed, which occur in very inferior cake, impart a very disagreeable taste. You may readily test this by the taste and the smell. When linseed-cake has been kept for a length of time, its mucilaginous properties more or less disappear. Mucilage is a substance that is very apt to spoil when kept in a damp place. If a cake does not become gelatinous on being mixed with water, it is not one of the best descriptions; but then the reverse does not follow as a matter of course. A cake may become gelatinous, and yet be inferior. Wild mustard and rapeseed very commonly occur in inferior linseed; when such cakes are mixed with water a more or less pungent smell of mustard is developed. I may observe, in passing, that rapecake ought always to be tested in this manner; for rapecake, especially that which is sold as Indian seed, very generally contains a large amount of mustard seeds, and becomes so pungent that it is extremely injurious to cattle. I have here a sample of a cake sent to me for examination not long ago, which had killed three oxen. It is a rapecake of the description just named—Indian rapecake containing a good deal of wild mustard.

Good cake, when examined by an ordinary pocket lens, ought to exhibit nothing but the husk of the linseed. When it is made into a

jelly, and the jelly is examined through a pocket lens, you can single out mechanically other descriptions of seed ; for their husks are left.

I have here a sample of cake branded "pure;" but it contains cotton husks. I have placed on the table a sample of cotton-seed and a sample of cotton-cake ; and these husks of the cotton seed have such a distinctive character that any one who examines the cake will recognise by the peculiar character of the husk the adulteration of the cake. Among the common materials used in adulteration is bran, a material which possesses some feeding properties, and may with advantage be given with linseed-cake ; but it is much more desirable to buy bran and pure oilcake separately ; for it is impossible to ascertain in what proportions they are mixed. The mere analysis of the cake cannot determine this point. Bran is often contained in cakes to such an extent that you can separate it mechanically ; but even then their composition cannot be estimated exactly. We have certain seeds which are particularly rich in albuminous, that is, nitrogenous substances. Other seeds and meals, mill-refuse, and matter like bran, are rather deficient in this respect. By mixing linseed with bran, and adding at the same time rapeseed, you make up for the deficiency of nitrogenous matter by the rapeseed. Thus a clever oilcake-mixer may readily produce such a mixed cake as will exhibit upon analysis the same amounts of oil, flesh-forming, and albuminous matters and the other constituents as are usually found in genuine pure linseed-cakes. The mere analysis, therefore, does not give any idea of the purity of the cake.

Allow me now to direct your attention to cotton-cake. Cotton-cake of the best character is now hardly ever met with in the market ; the horrible American war has cut off our supply. Cotton-seed has a hard shell, which, in some varieties, amounts to one-half the weight. The best cake is made from the kernel only ; but it is not made in this country, because we have not the proper machinery for shelling seed. This sample is a very good common cotton-cake, made of the whole seed ; this other, made from the kernel alone, is of a very superior quality. Here is a third and very inferior sample ; and yet another, which, in a particular instance, has done very serious damage to the stock to which it was given.

In the whole seed cotton-cake there is sometimes such an excess of husk or indigestible cotton-fibre present, that the animal which is fed upon it has not the power to reject it : a mechanical stoppage takes place in the lower intestines, inflammation of the whole intestinal canal ensues, and the animal dies. In these cases the death is frequently mistaken for a case of real poisoning ; but there is nothing either poisonous or deleterious in cotton-seed ; nevertheless, it acts injuriously, by causing a mechanical obstruction, and the result is the same as that sometimes produced by a strong irritant or a metallic poison. There is, indeed, great danger in giving the whole cake made of the seed indiscriminately, that is to say, in too large a proportion ; it ought always to be given in the form of meal, together with roots or other succulent food which have a tendency to keep the bowels open. During the last year or two I must have had a dozen

or two of so-called poisoning cases arising from the use of cotton-seedcake referred to me; but in no instance could I detect any poison. In one particular case, I found a large mass formed, as hard as a cricket-ball, in the lower intestines, evidently causing a mechanical stoppage that resulted in inflammation of the stomach.

Earthnut-cake is a useful and very nutritious cake when made of the kernel; but if the husk is ground up with it, it partakes of the same disagreeable properties which characterise the whole seed cotton-cake. The earthnut is an almond-like food; it is to some extent indigestible. The cake must not be confounded with nut-cake, which, as now sold in the market, is nothing more or less than the refuse kernel of the palm-nut. The American or earthnut-cake seldom passes as such into the hands of the consumer, because it is ground up with other materials and made into linseed-cake. There is another kind of nut-cake which is only fit for manure. It is made of a bean grown in the Cape de Verd Islands. Three or four beans are sufficient to produce a very powerful affection of the bowels, and in doses of an ounce this seed becomes a rank poison. Several cases of poisoning from the use of cakes which contained this bean have been brought under my notice at various times.

Poppy-cake is a good cake when it can be had in a fresh condition. It is remarkably sweet to the taste, and is nutritious; but in England, there is not a sufficient demand for it, and it is frequently a drug in the market. If stored it becomes mouldy and acrid to the taste, and is then more or less injurious to cattle.

This leads me to notice the injury which cakes of every description sustain from bad keeping. All cakes, as well as other feeding materials, get spoiled by being kept in damp places. When cake becomes mouldy, and the mould penetrates into the mass of the cake, it often produces serious injury to the animals. Now the mixture of bran is very apt to produce mouldiness in cake, because it keeps the cake light, and admits the damp air more readily, and this is one great objection to its use. I would recommend those who have not an extremely dry storehouse not to buy any bran-cake, because it will spoil in a very short time. Only yesterday, when selecting samples of cake to be exhibited here to-day, I was particularly struck with three which I took from the same parcel, sent me for analysis. One of them is a pure cake, and has kept perfectly well; the others are of the worst description; they contain a great deal of bran and other impurities, and have become very mouldy. And I have no hesitation in saying that both the latter, whatever they have been originally, are now injurious, if not downright poisonous. During the last year I have had many cases brought under my consideration, and could find no other explanation of the undoubted injury which the cakes have done to the cattle, than their being of this mouldy kind. Some cakes, which were evidently at one time most excellent and wholesome, have nevertheless done great mischief. I could not make it out for a long time, but now I think that it is the production of a certain fungus that has done the mischief. Invariably when the cake has done mischief, and no injurious seed could be detected with the microscope, I have found that fungi or

mould were the most likely cause of it. Inferior—that is, mouldy—oats have also in several cases done mischief. The experiments which were tried at the Veterinary College were so conclusive to my mind that I was induced to inquire into similar cases, and I have learnt since that mouldy cakes often produce serious injury to cattle.

This is another argument which I adduce in order to impress upon you that you should not rely merely upon analytical results. A knowledge of the percentage composition of the cakes may be useful, but it does not tell you everything. If you have three or four different kinds of cake, of equally good condition and equally fresh, then the analysis will bring out some useful results. It will point out, for example, which cake is the most fattening, which contains most oil, or most albuminous matter. We have then comparative results from which some useful information may be collected. But the mere analysis does not tell whether a cake is even wholesome or not. Of what use, indeed, would it be to analyze a cake such as I have referred to? Its mouldy condition is quite sufficient evidence to condemn it to the dung-heap. The numerous cases of poisoning with cakes that have become mouldy, brought under my notice, leave no doubt as to the serious mischief which they may produce. All refuse matters which have a tendency to become mouldy, or which contain fungi, are for the same reason injurious.

I have here a very strange mixture which has been imported at a low price by a gentleman who thought of giving it to his cattle. It is composed of the sweepings of an oil-mill and the warehouse of a general provision dealer. Having carefully separated its various constituents, seeds, and bits of oilcake, I could not find anything injurious; but under the microscope I discovered at first the germs of fungi, which have since developed so plainly as to be seen by the naked eye. The sample I now produce has killed not less than fourteen sheep, three horses, and a pony, belonging to this gentleman, who gave them only in a small quantity. The whole of the animals were killed within two days.

There is, therefore, very great danger in buying any description of food that is in a bad condition; and since chemical analysis does not express the condition or quality, we must not draw from analytical results conclusions which they were never intended to convey; and it is perfectly absurd for any chemist to say that you should rely more upon tabulated analyses than on any other examination.

With regard to other feeding materials, I will merely mention, in conclusion, that sometimes the consumer is not safe even when he sends his own barley to the mill to be ground; he may get barley-meal back, it is true, but with something else in addition. I have here two samples of barley-meal: one of them was returned from the mill mixed with sawdust—chips of sawdust, which you can pick out mechanically; the other was mixed with a considerable quantity of sand, in the proportion of nearly 10 per cent.! These admixtures gave to the barley-meal such a disagreeable taste that the animals would not eat it, and this led to the examination of the meal. The farmer may learn from

this the importance to him of dealing only with strictly honest men. But another safeguard in buying feeding materials is, not to be led away by a low-priced article. The finest description of linseed-cake is not to be bought at a low price. Low-priced cakes are generally mixed with other kinds of feeding materials that have a lower feeding value, and consequently a lower commercial value. Thus in the low-priced oilcakes—linseed-cakes—you have rape-seed, the whole seed of cotton, and other materials which reduce the value. A fair and reasonable price must be paid to secure a good article. I have thrown these different matters somewhat incoherently together, purposely with a view of eliciting discussion. I have not attempted to give a systematic lecture, in order to dwell more particularly upon matters which appear to me to have been overlooked to some extent, but which, nevertheless, have an important practical bearing.

LORD FEVERSHAM, when moving a vote of thanks, said, Allow me to ask if the Professor has had any experience of an article which has been attracting considerable public attention of late in the feeding of stock: I allude to the article of malt. This is a subject certainly of very great importance, and it has recently been stated that the duties upon malt operate powerfully as an impediment to farmers in feeding their cattle. Probably you will be aware that a numerous deputation waited upon the Chancellor of the Exchequer yesterday upon this subject; and without going at all into the political state of the question, I may state that the right hon. gentleman, in replying to the deputation, observed that he should be very glad to hear the opinion of any gentleman of experience as to the advantage and policy of feeding upon malt. The Professor, in his very excellent lecture, has touched upon the subject of barley, but not on the question of malt. He has clearly and ably pointed out the evils of adulteration, and the extent to which it is practised. He has told us of the admixture of foreign seeds and impurities to the extent of 30 and 35, or even 70 per cent. This shows how farmers are subject to imposition in *purchasing* these things. If they were permitted to use the produce of their own farms in a particular form for the feeding of cattle, it would be a great boon to them. They would thereby be relieved from the necessity of buying these adulterated articles of food, and there would be the pleasing prospect opened up of a less quantity of land passing out of cultivation, as regards cereal crops, than we have witnessed of late years. I find it stated that both in England and Ireland, but especially in Ireland, large tracts of land have ceased altogether to be cultivated for corn. Perhaps, in the case of Ireland, this may be in some degree owing to the humidity of the climate, or to the effect of its being ascertained that both soil and climate there are better adapted to the production of meat. But, of course, the more meat is produced, the greater is the importance of ascertaining what is really the best kind of food to give our live stock, with a view to avoiding the use of those articles which the Professor has described as containing so large an amount of adulteration—of absolutely poisonous and injurious substances.

MR. FISHER HOBBS, in seconding the motion, said, I am glad the noble lord has referred to the question of malt. Although the discus-

sion has more to do, perhaps, with the adulteration of oilcake and other feeding materials, still, I think, we should not be travelling out of our proper sphere if, after the exposure which the Professor has made with respect to the great extent to which adulteration is carried by the manufacturers of oilcake in this country, the question of malt as a feeding element be considered. The question introduced by the Professor was considered and discussed in this room a few years ago; and we then came to the conclusion that the English crushers of cake were more dishonest than the foreign; and that if we would have a genuine article, we could depend more upon the foreigner than upon the Englishman. Now, it must be very evident to all of us, from what the Professor has stated, as well as from our own experience, that there is the greatest imaginable difficulty in getting a cake that we can rely upon; and I know that many persons who have animals of very great value, with which they desire to compete with the noble lord's shorthorns, or with the great exhibitors of sheep, find it necessary to feed those animals—aye, and horses too—with malt. I happened to be one of the deputation that waited upon the Chancellor of the Exchequer yesterday. We went rather fully into these matters, and Mr. Booth, the eminent breeder of shorthorns, and a successful exhibitor, stated plainly that for years past he and his family had been in the constant habit of feeding their animals with malt. I can only say for myself that, during the last thirty years, whenever I made up my mind to exhibit and to win a prize, malt has invariably been the article upon which I fed my animals. That I did successfully for a very long period; and I believe that farmers, one and all, join in the hope that the Legislature will in some way get rid of the dreadful adulteration that is going on in the manufacture of oilcake. With regard to the conversion of barley into malt, I shall only add that, as far as my experience goes, I am so satisfied of the value of malt, that if its use were unrestrained, I should not spend a single penny more in the purchase of oilcake.

Professor VOELCKER, in answer to the question of Lord Feverham, said, At present our practical experience of the feeding properties of malt is very inconclusive. I therefore feel considerable hesitation in replying positively to the question either one way or the other. I have myself no experience on the subject, and can only quote the very imperfect and limited experience of those who have tried comparative experiments with malt and barley. As far as I know, the only experiments with which I am acquainted are those made by Mr. Hudson, of Castleacre, Mr. Lawes, and a few desultory experiments by Mr. Thompson. These, moreover, especially the latter, were made upon a very limited scale, and added little to our stock of knowledge. Still there is, no doubt, much of floating experience from which useful hints might be gathered. The feeders of stock that I am acquainted with speak very highly of malt. When an animal has to be got into fine condition, and supplied with a large amount of food in order to its rapid development, the addition of malt, from all I can learn, is most useful. It seems to help the digestion remarkably—I may say wonderfully. Now, we can easily understand this. For in malt not only the ready-formed sugar

acts usefully, but there is also a peculiar power of changing the starch in barley-meal rapidly into sugar. This accounts for the efficacy of malt in certain circumstances. When cattle are highly fed, I believe the addition of malted barley may prove of great utility.

Another question which strikes me as being of great practical importance is, whether by the addition of malt other food which is objectionable to a certain extent, on account of its indigestibility, may not be rendered more available for feeding purposes. On the whole, as far as I can see into the matter, I think the fattener of stock might find some valuable ends answered by the use of malt; and although I cannot, from our present stock of knowledge on the subject, say whether it would be desirable to replace barley-meal by malt, I have no hesitation in saying that in certain instances the liberty of manufacturing barley into malt would be a great boon to the agricultural community.

The vote of thanks was then put, and carried unanimously.

Mr. HOLLAND, M.P., wished to put a question as to the comparative feeding powers of a pure linseed-cake—that is, as pure a cake as could be got—when used alone, in contrast with the action of that cake when mixed with a certain proportion of bran and some other feeding materials. If the proper proportions are given, would not an animal feed quicker upon such a mixture than upon the pure cake alone, weight for weight?

PROFESSOR VOELCKER: The mixture of a certain proportion of bran would be very useful indeed. The animal would fatten better. It is also desirable to mix bran with cake when it is given to milking-cows. You get better milk and a larger supply. This is due partly to the better mechanical division which you get when the cake is mixed with bran, whereby the feeding properties of the cake are much increased. Some of the best and finest descriptions of cake are very hard, and when given in large pieces, do not readily fall into powder; whereas, when mixed with bran, they are more easily moistened, and readily digested. When cake is ground to powder, and mixed with bran, it becomes much more nutritious, and goes a great deal farther. There is in all descriptions of ordinary oilcakes a very large proportion of albuminous matter, and the addition of bran renders a considerable portion of this available which otherwise would go to dung. Upon the whole, the addition of bran to oilcake can be recommended; but it ought to be practised by the farmer himself, and not by the oilcake manufacturer.

Meeting of Weekly Council, April 29th. Professor WILSON in the Chair.

ON THE NATURAL HISTORY OF PARASITES AFFECTING THE INTERNAL PARTS OF THE BODIES OF ANIMALS, WITH THE NATURE, SYMPTOMS, AND TREATMENT OF THE DISEASES TO WHICH THEY GIVE RISE.

Professor SIMONDS said: The subject selected by the Journal Committee is so comprehensive that it is impossible to do anything

like justice to it in a single lecture, or, indeed, in a course of twenty lectures. The difficulty therefore is to epitomise the matter. Under these circumstances, he proposed to select one or two prominent affections to which domesticated animals are subject, and explain somewhat of the natural history of the parasites which are their superinducing cause. Parasites are met with in all structures of the body—not only in the internal organs, but also upon the external parts of the frame; and whether in the one situation or the other, they are more or less productive of mischief, provided they exist in sufficient numbers. It is not an uncommon observation that a few worms can do no great harm; there are, however, affections very destructive of the health and the lives of animals, which really depend upon the existence of worms, and often not in large numbers.

Parasites are thus classified:—First, the Epizoa, which live on the skin of animals; secondly, Entozoa, which inhabit the internal structures, without reference to location in any particular organ; and thirdly, Ectozoa, which occupy either the internal or external portions of the body for a certain time, whilst undergoing some of the transmutations through which they pass.

As familiar examples of the first of these classes, he would point to lice, ticks, mites, and so forth, well known as having their habitat on the skins of animals, and being productive of mischief in proportion to the numbers in which they exist. The *acarus ovis*, met with upon the skin of the sheep, is the direct cause of the affection called scab, and also of mange in the horse; in fact, the true mange of the horse and the scab of sheep are identical, and depend upon the presence of this parasite.

Of the ectozoa, the most familiar example is the bot in horses. Here a fly (*cestrus equi*) deposits its ova on the hair, which, by the licking of the horse's tongue, are carried into the mouth, and conveyed with the food into the stomach. The ova are quickly developed into larvæ or grubs when exposed to the heat of the mouth and the saliva. When they reach the stomach they attach themselves to its membranous lining by their hooklets, and there feed, not upon the stomach itself, but upon its contents, from the latter part of the summer, through the autumn and winter, until about midsummer in the following year, when they attain maturity. They then lose their power of hanging on, drop from their stations, mingle with the contents of the stomach, and, passing through the alimentary canal, are expelled from the body. Upon expulsion the chrysalis is formed from the larva, and in a few days the fly bursts forth. These creatures therefore exist for a considerable time altogether independent of their host.

THE ENTOZOA.

The class, truly termed entozoa, inhabit the internal structures of the body, dwelling, some of them apparently their entire lives, in that situation, and multiplying in the organ in which they are found. Many so-called parasitic-worms exist as ova, and, in other forms, in pools and in sewage, and being accidentally conveyed into the bodies

of animals, find a proper habitat there, become fully developed, and deposit in turn their ova, which are subsequently carried out of the body through the ordinary excretions. Entozoa are so numerous that it is necessary to classify them in order to understand anything about them. Some years ago he made such a classification, which, although it might not meet all the wants of the naturalist, may claim the character of simplicity, and of meeting the requirements of the pathologist; it is with this that we have chiefly to do to-day. Those creatures come, first, under the head of the protelmintha; secondly, of sterelmintha; and, thirdly, of coelmintha. Under the first of these heads we have the lowest forms of worm-life, hydatids. One specimen before us has been removed from the brain of a sheep during life, and the animal is doing well. The class includes the *acephalocyst*, the hydatid designated by the late John Hunter the pill-box hydatid. Then there is the *hydatis tenui-collis*, or long-necked hydatid, which is always found attached to the external parts of organs, and is apparently the most harmless of all the hydatids that affect an animal. Next comes the *hydatis cellulosa*, so called because it lies in the cellular tissue which connects the muscles together in different parts of the body. It is this hydatid which produces that peculiar condition in the flesh of a pig known as measy-pork, an affection to which the attention not only of naturalists, physiologists, and pathologists, but of the Government, was called during the Crimean war, because it was found that large quantities of measy-pork were being exported to supply our troops, the use of which must have resulted in producing tape-worms in the intestines of those who ate it. This term, "measy-pork," is an unfortunate one, inasmuch as it does not indicate the nature of the malady, and indeed is apt to lead to a wrong impression. No two things can differ more widely than a measy condition of the flesh of an animal and the eruption on the skin of the human subject, properly termed measles. In many respects our nomenclature is defective, and this is one special instance. The *cœnurus cerebralis*, already referred to as being found in the brain of the sheep, received its name from the circumstance that the creature possesses a large number of sucking discs, or heads; and the word *cerebralis* indicates that it locates itself within the brain. It is this creature which produces giddiness in the sheep. Lastly, there is the hydatid to which is given the name *echinococcus*, which also exists very extensively in domesticated animals, and when inhabiting the internal parts produces serious diseases in the organs.

SOLID WORMS.

Among the sterelmintha, or solid worms, are included all the tape-worms. One specimen of this class now before him was found in the sheep, and another in the horse. The latter is an interesting variety, termed the *tænia megaloccephalus* from the circumstance of its having a large head. Another, called the *tænia serrata*, from the serrated or saw-like margins of its body, is probably identical with the *tænia solium* in the human subject. And another most interesting and very

rare specimen is the *bothriocephalus*, so termed from its having a peculiarly formed head. The example produced was obtained some years ago from a dog. It is a variety of tape-worm not common in this country, but which exists among the inhabitants of Sweden, Norway, and the North of Europe. It measures seven feet long; and the dog from which he took it had been the subject of cutaneous disease, which probably depended upon the presence of this worm in the intestinal canal, where it kept up a perpetual irritation. The cause of rot in sheep is to be found in the existence of the sterelmintal variety of entozoa—the *distema hepaticum*.

HOLLOW WORMS.

The third class—the cœlmintha, or hollow worms—are those with which we are most familiar. It includes the *filaria*, or thread-worms, and among these are the *filaria oculi*, existing in the eye of the horse in India. Another worm, existing in sheep, and producing symptoms analogous to rot, inhabits the stomach, and draws largely upon the nutriment of the animal. It inserts its head, which is armed with barbs, into the mucous membrane, where the barbs enable it to hold on, or, by closing them, to withdraw its head at pleasure. To this I have given a name—*filaria hamata*—the hooked or barbed thread-worm. There is likewise the *filaria bronchialis*, found within the bronchial tubes of calves and sheep in particular, which produces that form of disease designated “husk.” This is the most common of the lot, and is to be met with in the bronchial tubes of every domesticated animal—in colts, in calves, in sheep, in pigs, and even in dogs. But it is in the herbivorous animals that the worm produces the greatest amount of mischief, and particularly with ruminating animals, calves and lambs; for all young animals are far more predisposed to the attacks of parasites than the old. I exhibit one example taken from a calf; another from a pig, in which the worms are crowded together in countless numbers in the ramifications of the bronchial tubes. Of late years this worm has excited a great deal of notice on the part not only of the pathologist, but of the practical farmer, in consequence of the sad losses which have resulted from its presence amongst flocks of lambs. At the present time a considerable number of lambs are affected with it, and within the last ten or twelve years the losses have been really very serious. It is very difficult to say why there has been of late an increase of entozoic diseases. Whether it has arisen from any particular condition of the atmosphere which was favourable to their propagation, he could not say; nevertheless, the fact is well established.

The natural history of these filariæ is by no means difficult to understand. They exist in the form of perfect males and perfect females; the sexes, however, are by no means equal, the females being as 50 or 60 to one. This worm is one of those creatures which may be called ovoviviparous; for occasionally it will happen that the young worm is so perfected while the ovum is within the body of the female that it escapes from the egg, and exists as a living worm before passing through the so-called ova-duct.

One and the chief reason why the worm is so destructive to sheep and other animals, is the fact that the young worms are perfected within the part where the ova are deposited. Now, little harm, as a rule, will arise unless the worms are present in large numbers; but supposing one impregnated female only to inhabit a bronchial tube of an animal, that female would in process of time produce such myriads of worms that the animal must inevitably fall a sacrifice.

The questions how the animals receive these worms, and how they come to occupy the ramifications of the bronchial tube, are difficult to answer. Although the worms are ovo-viviparous, and find their proper habitat within the bronchial tubes, nevertheless, ova ejected with any mucus that may be coughed up—and cough is a leading symptom of this disease—might remain as ova for an indefinite length of time upon pasture-land without losing their vital properties or power of development, and animals feeding upon the ground may receive the eggs in the process of gathering their food, from which the young worms would be quickly produced. If an animal takes anything into its mouth with which there are a certain number of ova, imperceptible to the naked eye, these ova may be retained about the mouth with the mucus, or saliva, long enough for some of them to be hatched. Such worms would then find their way, not into the stomach, but into the bronchial tubes: the females would soon eject eggs, and the result would be a considerable brood of these creatures. Take the minutest portion of the ova-sac of a parent-worm, examine it through a good microscope, and such myriads of eggs will be seen on the field of vision that no one would think of attempting to count them. So that one worm literally brings forth thousands of others. These, getting into the ramifications of the bronchial tubes, pass even to the air-cells of the lungs, where, by the irritation they create, they lead to condensation of the lung structure, and destroy the lung in these parts as an aerifying organ. The affected lambs fall off in condition, have a constant cough, and, gradually wasting away, ultimately become affected by diarrhoea, which usually carries them off. Many persons, upon observing their animals attacked with diarrhoea, attribute it to ordinary causes; whereas, it is in reality a general break-up of the system, depending, not upon a disease in the digestive organs, but upon the presence of these worms within the ramifications of the bronchial tubes. It is not at all an uncommon thing for 50, 60, or 70 per cent. of a flock of lambs to be destroyed from this cause.

REMEDIES.

The means at our disposal for getting rid of these entozoa consist of resistance to their attacks, and an endeavour, if possible, to destroy them where they are, and thus effect their expulsion. These must be the principles to guide us whether we deal with worms as existing in the bronchial tubes, or any other part of the organism. When, however, they exist in such numbers as to produce an organic change of the lungs, no kind of treatment can possibly avail; early treatment before a change of the lung structure has come on, or the animal has

wasted much, can alone be successful. Our object then is to impart strength and energy to the constitution of the animal, or to make the habitat of the parasites unpleasant to them, and if possible destroy them in the situations in which they are, so that as dead matter they may be expelled in the act of coughing, or with the ordinary secretions. To strengthen the constitution, the animals should be supplied with the most generous food in a concentrated form. Instead of keeping them simply upon grass, artificial or natural, during the summer months—for it is in the summer, or on the approach of autumn, that they are generally affected—or feeding them upon turnips alone in winter, it is necessary to throw into their systems as much nitrogenous food as possible. Cake, corn, and so on, should be used unsparingly in every case of the kind. Such food should be given early, because when diarrhoea has once set in, the system is in such a weakened condition that it will then be of little or no use. The cause of diarrhoea is rather an important question in adopting medical treatment in cases of this description. It appears to depend not so much upon the mere prostration of the vital powers of the animal as a whole, as upon the weakened condition of the powers of digestion and assimilation. Everybody knows that even when our digestive powers are strong, if we take anything into the system which is not very digestible, it irritates the stomach and intestinal canal, and is frequently ejected from the system with diarrhoea. Nothing, indeed, is so common as to have an ordinary attack of diarrhoea just simply depending upon indigestible matter taken into the system, from which nature frees herself as quickly as she can. Apply the same reasoning to the organisation of the sheep. When its powers of digestion and of assimilation have become exceedingly weak, the food, instead of being digested and appropriated to the requirements of the system, acts as an irritant to the stomach and bowels, and passes off undigested and unappropriated through the intestinal canal. What, then, under such circumstances, would be the use of giving cake, corn, &c.? Why, it would be no more digested than ordinary herbage; for, if grass could not be digested, surely cake and corn could not. But while the digestive organs are not affected to any considerable extent, we may strengthen the constitution of the animal by giving it highly-nutritious food.

Of the anthelmintic agents given as remedies, some are good and powerful, and some of no use at all. Practice has shown that turpentine, in conjunction with a little oil, and tincture of *assa-fetida*, is about as nice a compound as can be given. Turpentine is a very old remedy in diseases of this description, and it is particularly serviceable and valuable, because it is eliminated from the system through the medium of the respiratory organs. We want to bring something to bear as directly as possible upon the parasites in the situation which they occupy in the ramifications of the bronchial tubes. But, if any medicinal agent directly descends the windpipe, it would only produce more mischief, and be the means of carrying off the animals whose lives we desired to preserve. The alternative is to

impregnate the system with an agent which may be afterwards carried off through the medium of the respiratory organs, and thus assail the habitat of the worm. Turpentine, which, when given to an animal, is eliminated from the system partly by respiration, partly by the urinary secretions, and partly by the intestinal canal, is such an agent as we require. If proof of this be wanted, let turpentine be given—say to a number of calves; walk into the field where they are, a day or two after; stand near the animals and catch their breath, and you will detect the smell of turpentine as plainly as possible. Assafoetida is also an excellent anthelmintic, and an old remedy, but not so generally given for these affections as it ought to be. In the form of the tincture it is a stimulating agent, and would also be eliminated through the system by the respiratory organs.

From half an ounce to an ounce of turpentine would be the proper dose for a calf, according to its age. Or you may take 3 ounces of oil, add to it 2 ounces of tincture of assafoetida, and 1 of turpentine, and administer this compound daily for three or four days in succession, when it should be discontinued for the same space of time, and then given again. You must not expect to get rid of the disease with one or two, or even three doses; but the system of the animal would be impregnated by occasional and repeated administrations of the agents.

There are other means besides these of strengthening the system, viz., by alternating, with the anthelmintic, ordinary tonic agents, such as sulphate of iron and ginger in combination, to give tone and vigour to the digestive organs. Sulphate of iron is an agent which keeps the blood in a state of purity, because it enters into chemical combination with one main constituent of the blood—the red cells. There is yet another course at our command which may be brought to bear directly upon the worms themselves—that of making the affected animals breathe a medicated air. This is a mode of treatment far too much neglected by the farmer. When consulted by persons who had derived little benefit from the exhibition of the anthelmintic compound just referred to, he had recommended them in addition to get the animals to breathe a medicated air. It will readily be seen that if the atmosphere can be impregnated with anything that is either detrimental to the lives of these entozoa, or calculated to render their habitat unpleasant to them, this will prove an effectual means of getting rid of them. One simple method of dealing with sheep in a mass, is to drive them into a close shed, or some other convenient place, and there to burn something which will disengage gaseous matter which the animals will be compelled to inhale. The most efficient agent for this purpose is chlorine gas; but then it is very destructive of life, and in the hands of an ignorant person might destroy the lives of the animals which it was intended to save. The *modus operandi* is to decompose common salt or oxide of manganese with sulphuric acid, by the application of a little heat. The person who does this must hold the apparatus in the shed until the air is sufficiently impregnated to render it unpleasant to himself. He should then retire with the apparatus, close the door, and leave the animals to inhale the medicated air. If carried beyond this, great

mischievous might result. Another simpler and safer plan is to impregnate the atmosphere with the fumes of sulphur, which may be done by igniting a little pitch, tar, resin, or anything of that kind, and then throwing upon the burning mass a small quantity of sulphur from time to time. The fumes of sulphur so thrown off will pervade the place in which the sheep are, and consequently be inhaled by them. No harm ever ensues from this where only ordinary care is used. Such, then, are the means we possess of giving relief in cases of this particular entozoic disease.

He would next notice another parasite which does great mischief to lambs and sheep especially, owing to its producing diarrhoea. There is one form of "scour" that is absolutely and directly due to the presence of entozoa. These entozoa, however, are totally different from those we have been considering, and, strictly speaking, they are not filariae. The technical name it bears is *Trichocephalus affinis*, which signifies a hair-headed worm, allied to the one met with in man. The worm as a rule, inhabits the larger intestines of the sheep, and is oviparous. The young are hatched directly from the ova, and consequently there are no transformations through which the worm passes. Like the worms before alluded to they exist as perfect males and perfect females, and there is about the same proportion between the sexes. The young trichocephali may be hatched within the intestinal canal, or the ova may be cast out with the faeculent matter, and lie in the pastures, where, fortunately, thousands upon thousands of them perish; but if only two eggs enter the organism and attain perfection as male and female, a great deal of injury will be sure to follow. The ova are, indeed, frequently received into the digestive system of sheep through their food and drink, and there, finding warmth and moisture in their semi-perfect condition, the young worms quickly escape, and begin to develop within the intestinal canal. The trichocephali are so productive of mischief, from the circumstance that they insert their heads into the mucous membrane, and draw their nutriment, if not directly from the blood, yet from its immediate pabulum. When worms like these exist in large numbers, they must be productive of an immense amount of irritation, which leads to diarrhoea; and as this form of diarrhoea will not yield to ordinary treatment, a great number of sheep are necessarily lost. These trichocephali appear to be as common as they are mischievous. Everybody knows that vicissitudes in the weather, a luxuriant growth of grass, too large a quantity of green food, turnips, and so on, will produce "scour;" but if no such causes as these are in operation, we may begin to suspect that any existing diarrhoea is attributable to trichocephali. Again, if upon a *post-mortem* examination of these wasted animals no filariae are detected in the bronchial tubes, it may readily be inferred that the cause may be found in the presence of these worms in the intestinal canal.

The means of getting rid of them are in principle, though not exactly in detail, the same as those already mentioned. A fair and free use of common salt will be effectual, and the more so because these worms are in the intestinal canal, where salt can be brought to bear directly upon them. Sulphate of iron can also be brought to

bear immediately upon the worms. Some persons attribute the efficacy of sulphate of iron to the circumstance that these creatures have no iron in their blood or circulating fluid. Whether this be the correct explanation he could not say; but he mentioned it simply as a notion that is floating in the brains of some persons on the subject. Sulphate of iron, however, should not be administered to the animals on the same day as the salt. The salt may be given to the extent of a quarter or half an ounce at a time, but the farmer should not go beyond a quarter of an ounce per day in its continuous use. Salt and sulphate of iron may be given with the food on alternate days. Half a drachm of the latter is a full dose even for a large sheep. The daily and long-continued use in this manner of sulphate of iron and salt will be found to be a most efficient means of getting rid of the trichocephali. The efficacy of the agents will be observed if the feculent matter of the sheep is watched; these worms will then be seen to come away rolled up in little masses. As soon as they get notice to quit they congregate together, twist themselves up into balls, and in that form are expelled from the system.

A NEW WORM.

He would next make a few remarks upon a worm only recently brought under his observation, which if not new to us in this country, is at any rate an undescribed variety of the filaria. The *filaria hamata*. His attention was first directed to it in the year 1858. A gentleman who was accustomed to breed some of the finest quality of Southdown sheep, and to rear his ram lambs for the purposes of stock, found in that year that, although he took every possible care of the lambs, they nevertheless wasted away in condition until they died. Various changes were made in their feeding, but all without avail; and at length he was asked to go down and investigate the cause of this state of things. The lambs had given no evidence of any particular disease, but were continually wasting away; their appetites were good, their secretions and excretions natural, and they had no cough nor any symptoms of disease of any particular organ of the body. The owner, an intelligent man, had opened some of them, yet could find nothing amiss; the intestines, the heart, and the lungs were apparently—so far as he could discern—healthy, and quite free from disease.

On his arrival at the farm he saw among 25 or 30 of these lambs, some 6 or 7 which were evidently in the last stage of the affection; but on the most careful examination he could then give them he failed to detect the existence of any kind of disease. It was suggested that one of them should be killed, and a *post-mortem* examination made. This was done; still there were no traces of an organic disease to be seen. At first he was somewhat puzzled, when, as he had long held the opinion that a good many diseases are exclusively and entirely due to entozoa, the thought struck him that it was not improbable that parasites might be found in the intestines. These were accordingly opened, in the expectation that trichocephali might be found there, but not one could be seen. He then opened the stomachs, of which ruminating animals have four, though one only is the true digestive organ, and

found that the three anterior ones were not at all affected. No entozoa were to be met with. There was then only the true digestive stomach left, and upon cutting into it he must say that he was hardly prepared for what was observed. The instant it was slit open, his eye being somewhat quick in catching sight of entozoa, he at once exclaimed, "Here is the cause?" The stomach was literally as thickly covered in places with these worms as the head of a man with hair. There they hung, their heads being burrowed in the mucous membrane of the stomach in myriads. He first thought the case must be as exceptional as it was remarkable. He had since examined the worm microscopically, and observed that although there was a great deal in its natural history which he would have to work out hereafter, he had still satisfied himself as to its anatomical peculiarities, which justifies the name that has been given to it. Immediately behind its head are four barbs, like those of a fish-hook; so that when the head is inserted into the mucous membrane, these barbs hold the worm fixed, and from that situation the attrition of the food fails to dislodge it. This proved not to be an isolated case; for in the course of a short space of time he was consulted in other instances where these worms existed in sheep of all ages, and placed under every variety of circumstances in regard to food and management. No breed of sheep appears to be exempt from—no particular system of management gives security against—the attacks of these parasites; and he had subsequently met with instances of the presence of this worm in the most remote western, as well as the most remote eastern, counties of England. It evidently is greatly on the increase; but where it came from he could not say. Various means were resorted to for the purpose of getting rid of these parasites; but at first they all proved ineffective for good. Turpentine was tried—it was of no use; sulphate of iron, and several other agents, but all were of little avail. He thereupon determined to try what would be the effect of a large dose of salt administered as a draught, and it turned out to be a most efficient agent. The sheep he tried it upon were some ewes belonging to the brother of the late lamented Jonas Webb, which were thought to be affected with rot. But then, as everybody knows, rot is never seen on the open heath-lands of Cambridgeshire, and these ewes had been nowhere else. Mr. Webb was naturally puzzled to know why they should be wasting away, and dying with all the outward appearances of suffering from rot. In that instance a large dose of common salt—as much as three-quarters of an ounce, and in one case a whole ounce of salt, dissolved in a half-pint of water, was given to a sheep. By this means hundreds of these creatures were removed; and from that moment might be dated the recovery of the animals. He had since experimented frequently in the same way, and always with the like success. These doses of salt, however, must not be repeated often, for they become very dangerous, and are really poisonous to the system. But there is no reason for apprehending danger or mischief in any way from the exhibition of one or two such doses as he had mentioned, administered at proper intervals.

He had now a practical suggestion to make, which might be worthy of

the attention of agriculturists whose sheep are affected in this manner. Some farmers—particularly in the county of Suffolk—have found that when their lambs are affected with this description of worm they got rid of them after a certain time when fed upon green rape, or coleseed, which is an excellent food for sheep. He made this statement on the authority of observant and trustworthy men in Suffolk, and he could well understand that this may be so, because many vegetable agents, when taken in their crude and natural condition, are known to be good anthelmintics.

He would gladly have extended these remarks further, and treated on other entozoa, but as he had stated at the outset, the subject is of too comprehensive a character to be dealt with in the limits of a single lecture. He had, therefore, been able to do little more than allude to some of the more prominent of these destructive creatures, so as to lay the basis for a paper on the subject in a future number of the Society's Journal.

Lord BERNERS, in proposing a vote of thanks to the Professor for his able and interesting lecture, wished to ask the learned gentleman how, in the case of the tape-worm which promotes a cutaneous disease in a dog, the existence of the worm is to be ascertained, and what are the best means of destroying it? And also whether there is an affinity between the *filaria bronchialis*, which is so destructive to lambs, and the worm which causes the gapes in fowls and young pheasants? For the destruction of the latter worms he had recommended, and had occasionally used, a little turpentine, which he applied on the tip of a feather, with some success; but this remedy was not to be trusted in the hands of the persons who reared his fowls, and had accordingly been discontinued.

Professor SIMONDS replied that the worm which produced the cutaneous eruption in a dog was often the tape-worm. Now tape-worms might exist in the intestines of all animals; and the best evidence of their presence perhaps was to be found in their detaching the posterior segments of their bodies and these being voided with the feculent matter of the animal. It is an interesting fact that these segments contain the perfected ova of the creature, and these ova, if they are accidentally conveyed, with the food or otherwise, into the system of sheep, especially young sheep, are very speedily developed into hydatids. In fact hydatids in the brain of the sheep may be produced *ad libitum* by simply giving these segments with the animal's food. To show the powers of endurance of the tape-worm against the agents which are administered for their expulsion, he would mention the particulars relating to one of the worms he had had by him for the last thirty years. Being desirous of killing a dog for the purposes of science he tried to poison it by prussic acid; but the prussic acid which he purchased in a country town was not very good, and the first dose failed to destroy the poor creature. He then gave him a larger dose with the like result, and at last he had to kill him by other means. When opened it was found that the prussic acid had completely denuded the intestines; nevertheless, there was the tape-worm still alive and crawling about!

The arica nut, when given to dogs and other animals suffering from the existence of tape-worms, is found to be a most powerful remedy. It should be administered in the form of powder to the extent of a drachm: but generally a teaspoonful mixed with a little water is given to the dog fasting, and if there be a tape-worm in the intestines it will almost certainly be expelled in the course of a few hours. The arica nut is a remarkable anthelmintic, and it is not less remarkable that it had never, that he was aware of, been given to the human subject.

Lord BERNERS observed that he had used the nut with great success as a remedy for common worms.

Professor SIMONDS.—With regard to fowls and the existence of worms in their windpipes, the worm is not the *filaria bronchialis*—nor is it allied to that description of worm. It is termed *syngamus trachealis*, and is believed to be the connecting link between the bi-sexual worm and those in which the sexes are separate and distinct. The worm very rarely exists in larger numbers than about two or three, though he had met with as many as seven in the windpipe of a chicken. It was a true bloodsucker. It fixes its head in the mucous membrane, and exhausts the power of the chicken by sucking its blood. This worm is met with in all the gallinaeous tribes of birds, whether wild or domesticated. Hence it is often the cause of great loss in the rearing of pheasants and partridges. Great numbers of rooks are also killed by it; but, singularly enough, aquatic birds, such as ducks and geese, may march about with perfect impunity amongst other birds affected with the *syngamus*. One means of getting rid of the worm is entirely mechanical; that is, to pass a feather into the trachea and give it a sweep round. The worm attaches itself to the barbs of the feather, and is thus brought away. There is no occasion for dipping the feather into turpentine; it is indeed only the more likely to kill the chicken. Under this treatment, however, many chickens are destroyed, and the best way of getting rid of the worm is by making the birds inhale a medicated air, and inducing them to take up little pellets of food mixed with *assafoetida* and turpentine. Let a few grains of barley, for example, be steeped in turpentine and thrown down with others to the poultry. The birds will then pick up the grains indiscriminately, and if they pick up the steeped grain with the others, the worm is got rid of. The fumes of tobacco are also an excellent remedy. Let the chickens be placed under a tub, propped up a little on one side; then burn the tobacco on the outside, and let the draught carry the smoke under the tub. Do this, and, with the assistance of *assafoetida* pills, you may soon destroy the *syngamus trachealis*.

In connexion with this discussion the following extracts from the Journal of the Bavarian Society of Agriculture (1861) may be read with some interest.—P. H. F.

The *Trichina Spiralis*.—A remarkable case of death arising from the effects of this entozoon occurred in January, 1860, in the hospital of Dresden, in the person of a female farm servant belonging to the

neighbourhood. The case excited much attention, both from the extraordinary symptoms—the excruciating pains and cramp—which accompanied the malady, and also from the results of the post-mortem examination, when both in the bowels and in all the muscles (even those of the heart) worms were found not only impregnated, but teeming with young.

Professor Zeuter, who had attended the patient, on inquiring at the farm of her master, ascertained that a pig had been killed on the 21st of December, and shortly after the maid had begun to be ailing; and that on the 12th of January she was taken into the hospital, where, on the 27th, she died.

“A direct statement as to how much raw meat she might have appropriated, could not be got at.”

There were still remains of this pig in the house, and on the first experiment made on the ham, very many *Trichinae* were discovered in their usual form. Sausages made from the brain and the blood exhibited the same results; it was evident that the girl had died from eating this meat.

The farmer, his wife, and other members of the family had all been affected with more or less violent symptoms of diarrhoea after this pig was killed; the butcher had suffered most, having had a violent pain in his limbs, besides the other symptoms.

1. The *Trichina* in man is thus traced to the flesh of swine, and does not originate in the dog, as Leukhart supposed. It is further evident that the *Trichina* completes the whole circle of its existence in one habitat, though further experiments are required to show whether this is always the case. Leukhart reared *Trichinae* in the bowels of a dog and developed them in swine, which in consequence became diseased. The pig may very well pick up impregnated worms from the dog's excreta. Thus the mischief may easily be propagated through the whole stock, and may slowly and steadily increase, the danger augmenting with the number of the worms. The *Trichina* is no offshoot of another worm (of the *Tricocephalus* as it was once supposed).

2. The *Trichinae* contained in the flesh or the dung leave the stomach of another mammal, and grow in the bowels to the size of 4 lines. They have been found in the stomach of the dog, the pig, and the rabbit.

3. Meanwhile numerous embryos are formed in the body of the *Trichinae*, which leave their parent by the sexual opening at its anterior extremity.

4. Many *Trichinae* proceed from the bowel, pass into the mesenteric glands, and so into the flesh: this migration is accompanied with the risk of a severe or even fatal illness.

This worm was discovered twenty years ago by Professor Owen, and it was called *Trichina spiralis*, from its thinness, and from the manner in which they were found in human flesh in a twisted form as thin-coated larvæ.

Leukhart found them at large in the muscles before they became larvæ; he also made known that they become impregnated during their abode in the stomach and bowels, and are viviparous.

Feeding experiments with the flesh of animals which held them in

the form of larvæ further showed them in the bowels of their new host; the capsules soon open, the young worms set at liberty soon are impregnated, and the brood then passes from the bowels into the flesh. They here come to maturity in three or four weeks, to then await, in a capsuled form, either liberty in a new body, or death in their old habitat.

Meeting of Weekly Council, May 15th. Lord BERNERS in the chair.

Paper on STEAM CULTIVATION, by Mr. E. RUCK, of Castle-hill, Cricklade.

Mr. RUCK said: Having been requested by Mr. Holland, on behalf of the Journal Committee, to give my experience of steam culture, I have readily consented to do so; but you must allow me to observe that I have never appeared thus publicly before, and that I am no learned professor, to keep your attention engaged for two or three hours on a stretch, but shall in all probability run out all the wind I have in less than thirty minutes. I particularly wish to guard myself against being considered to be an advertising medium, or in any way desirous of supporting one system of steam cultivation to the detriment of another. It is my intention to speak "the truth, the whole truth, and nothing but the truth," so far as I am able; and if I am misunderstood, I shall be happy to give any explanation in my power.

You are, of course, all well acquainted with the names of the makers of steam cultivators—Fowler, Smith, Fiskens, Howard, Stevens, Coleman, Hall, Halkett, Boydell, and others. Thirty years ago, I find Baxter writing thus: "The injudicious agriculturist goes blundering on in the footsteps of his forefathers; in some of his operations being perfectly right without knowing why he is so, and in others egregiously wrong, yet not able to detect the cause of his error." This remark will, I hope, stimulate the farmers of the present day to turn their minds to the study of steam culture. Science has done much for agriculture during the last ten years. Superphosphate, I consider, has been a wonderful thing for light lands; and I believe that steam-power is destined to do quite as much.

I look upon farmers like a flock of sheep running through a gap: it is very difficult to get one to start; but when once he does start, they all run in a body.

Allow me here to say a word respecting myself, and to state that I am a farmer living upon the same farm that was occupied by my father and grandfather for upwards of seventy years. I used to work fifty-six oxen, making seven teams in the morning, and seven teams in the afternoon. At that time I had an opinion that we could do work with oxen free of cost, and that, as I had 150 acres of grass-land, the oxen would generally by their improvement pay the rent, though they would not give a profit upon that grass-land. I am entirely dependent on the profits of farming, and consider no system of culture worth notice if the balance-sheet does not show that it is profitable. I have had

considerable experience in steam cultivation, and am now growing upwards of 400 acres of wheat, all planted after the steam-plough with Fowler's tackle.

This remark brings me to the question, What must be the size of a farm to which the tenant may properly apply the use of steam-tackle? I should reply, 800 acres of arable land for such a 14-horse set as I have been in the habit of using. After all, a tenant cannot be expected to embark in steam ploughing unless he has a proper holding. It would not be fair to require him to make a great outlay if he has only a yearly tenancy, with the chance of being turned out of his occupation on a six-months' notice to quit. There are roads to be made, and it is of the greatest importance in steam culture that you should have good roads; in fact, I think the day will come when the engine will work on the roads, and not have to enter the field at all. Two-thirds of my occupation I can farm in that way. Then the fences must be made straight, and the fields must be made larger. The expense of moving the tackle from one field to another is considerable, and that would be avoided by putting the fields in a proper form for the steam-plough. I am pleased to tell you that I find nearly all my neighbours engaged in preparing their farms for steam culture.

My order to Mr. Fowler was given at the Chester meeting of this Society in 1859. *I then sold my oxen*, and continued the use of steam in 1860, 1861, 1862, and up to the present time; and the whole of the cultivation of my land has been done by that means, that is, so far as ploughing and heavy dragging are concerned.

I should be sorry to give offence to any one, but I consider that the reason why steam cultivation has not been more generally adopted is, that the landlords as a body have not put their shoulders properly to the wheel. I am happy to say, however, that there are honourable exceptions to this rule. One of these is my own landlord, the Earl of St. Germans, who, when I began operations, gave me liberty to throw my occupation into a steam-plough farm. I may also mention the name of his Grace the Duke of Bedford, who has presented a tenant of his with a piece of plate for the energy and enterprise he has displayed in the application of steam. And lastly, there is Major Calley, near Swindon, where I believe the first set of Fowler's tackle was used by Mr. Redman. Speaking of the removal of hedgerows, I have somewhere seen a calculation made by Mr. Mechi, according to which every tree upon arable land costs the tenant 13s. 4d. annually. With regard to dairy farms, I do not think it necessary that they should be large; as the farmer, his wife, and family may then do most of the work.

The next thing to which I would direct your attention, is that by the use of steam we get the land into such a state as to constitute it what I should call good land. You must have a deep surface soil with a porous subsoil, so that the water will in no way do it an injury, nor the sun burn it up. This is done on all lands when under spade-husbandry, and you will always find that land greatly improved. Allotments, for instance, are a great deal better to look at (and they

are better) than lands alongside of them which have been under the plough for years.

With respect to drainage, I used Fowler's draining plough without pipes by horse-power in the year 1851, and the drains are good now, and the line of the drain can at the present moment be seen in the growing wheat, which is there much better and of a darker colour. This I attribute in a large measure to the aëration of the soil.

During the last season I have used one of Fowler's steam draining-ploughs on the Manor Farm, and it has worked very successfully. The mode in which we use it without pipes is this: we start the mole-plough at the bottom of the field in the main drain or ditch, and work it up-hill, so that no water ever lies in the drain at all, but the moment it gets into the drain it runs into the outfall and is gone. I only put three pipes to the mouth of each drain. This is when you have open main drains, which I consider preferable to close mains upon clay lands, on which the water runs off so hastily that it is difficult to drain any large extent on the other system. I have found that clay lands, drained by the draining-plough, have answered better than when manual labour has been employed, the land on each side being well shaken for at least a yard as the mole-plough passes on; the land is thus raised, and the water percolates much more quickly through.

It is not my intention to trouble the meeting with a long array of figures. I prefer confining my remarks to one day's work, of which I give you the cost. I think you will thus be enabled to arrive at a better conclusion than by my giving a lot of figures, because different farms imply different land, different labourers, and different management altogether. Now, the prime cost of Fowler's 14-horse set is, I believe, about 945*l*. My daily outlay is, for

	s.	d.
Engine-man	3	4
Ploughman	3	4
2 porter-men at 2s.	4	0
Anchor-man	2	0
1 man to supply water and coals	2	0
1 horse	2	4
Oil	1	0
Coals	10	0
	<hr/>	
	28	0
For wear and tear, breakages, and other expenses ..	12	0
	<hr/>	
Total cost per day	£2	0 0

Some gentlemen may think the allowance for a horse too low, but I have always been of opinion that a horse ought to be put at the same price per day as a man, because the cost of his keep is about equal to the wages paid for a man's labour. The quantity of coals used is 12 cwt.

You will observe, by what I have stated, that I have no boys. I prefer employing men only, believing it to be work hard enough to require men. With this power you will be enabled to plough an acre of land in one hour, or 8 acres per day. You will also have sufficient

power to attach the drag to the plough, and thus do the work twice over in a place. This work of 8 acres a day will cost 5s. per acre. Scarifying we can do at the rate of 16 acres a day with a drag attached. This would cost 2s. 6d. per acre.

The first work I have mentioned, with plough and drag, I should estimate to cost 15s. per acre if done with horse-power. The second work, with scarifier and drag attached, if done with horse-power, I should put at 7s. 6d. per acre. The ploughing would be done 6 inches deep, and the scarifying 10 inches deep; and the cultivation by steam would be far superior, for I consider one operation with steam to be equal to two by horse-power. I think that when steam comes to be more generally used, and you pay the men for the work done by the acre, instead of, as at present, by the day, it will be a great boon to the farmer.

I consider that a crop of beans affords the best means of getting the soil into proper condition immediately after it has been turned up deep by steam cultivation.

The advantage which steam-culture offers to the landlord, I am inclined to place very high, since I am of opinion that the value of land may be increased one-third by its use.

I take it that a 14-horse set will do as much work in a day as 30 horses. You can use it whenever the weather is fine, and it eats nothing when not at work; the steam-horse never tires. You can get forward with your work by making longer days, and it might perhaps be advisable to use two sets of men; the work done is far superior to any done by horse-power.

The land, after steam-culture, drains very much better. I know the case of a piece of land which had been drained 14 years, yet it lay quite wet under horse and oxen culture; but since it has been cultivated by steam I have never seen a drop of water on its surface, though no alteration has been made in the drains, which are now just what they were 14 years ago. The soil is a particularly tenacious clay, of the Oxford kind; and this land you can drain without using pipes.

I believe that all land would be greatly improved by the application of steam-power, but I particularly wish to draw your attention to its use on light lands; for it is upon the light lands of England that I consider there would be the quickest return, inasmuch as by one operation you would entirely change the nature of the soil. You prevent its burning or frying up, and you could thus render a great quantity of land capable of growing beans which is now altogether unsuited to that crop. I put the cost of ploughing by steam, with a drag attached, at 5s. an acre; the cost of scarifying, with drag attached, at 2s. 6d. an acre; and the cost of digging, that is, working Fowler's digging-breasts, at 5s. an acre. The cost of draining, with a mole as large as a quart decanter, at the depth of a yard, without pipes, I put at 8d. per chain, or 10s. an acre, at 40 chains to the acre, one pole, or 16½ feet apart.

One great advantage of steam cultivation is that, when the day's work is finished, and the fire is put out, there is no baiting, and no

harness to take off. The labourer therefore makes the most of his time; he has not to walk, in the morning, first to the stable and then to the field; but he goes direct from his home to the field, and returns direct to his home as soon as the day's work is done. The land works better and quicker after rain when steam-ploughed than when horse-ploughed. In fact, I have been drilling on clay land in wet weather, when my neighbours could not get upon their gravel or brashy land. I find the soil, when under steam cultivation, is much improved by atmospheric influences; and if (as has been stated) the rainfall is 26 inches, it will seldom do any damage to land so managed. The same effects may be noticed in the case of garden allotments, which do not often require draining in consequence of their superior cultivation.

Again, I find that superphosphate will act much better upon strong land after being cultivated by steam than after horse-power. This I attribute to the finer tilth produced. Superphosphate upon clay land in a rough state will do no good; but it will accomplish wonders upon such soils if worked down fine.

Further, under steam culture you increase the size of the worms; and there is no better criterion than this of the state of land and its fitness to grow a crop: where you have no worms you will have no corn. It is rather strange that nitrate of soda kills the worms in half-an-hour from the time it is sown. I do not know how to account for that; but doubtless the Royal Agricultural Society, with the great amount of science which it has at its command, can explain why, where there are the largest worms and the greatest quantity of them, there you will have the largest crop; and why nitrate of soda kills the worms within half-an-hour of its being sown. Whilst referring to worms, I would observe that no grass-land which is subject to worm-cast can be of a good quality; this is the result of the observations which I have made for the last five-and-twenty years.

With regard to the outlay which steam-cultivation requires, if you can do as much work per day by the steam-power I have mentioned as with 30 horses, the prime cost for the power I should put as equal, allowing that 30 horses with harness cost 900*l.*, and the implements they work 100*l.*, together 1000*l.*, whilst the prime cost of a 14-horse set cultivator is 945*l.* There is yet another reason in favour of steam-cultivation, namely, that farmers now generally use thrashing machines, and upon a rough calculation the outside cost for thrashing on a farm of 800 acres would be about 80*l.* a year, and on the same farm the horse-cultivation would come to 800*l.* There is a greater margin, then, for saving where you have an outlay of 800*l.*, than where you have one of only 80*l.*

The plough, from its wedge-like form, will turn over a greater weight of soil with less cost than any implement that has yet been brought out, but with the cultivator you go an extra depth, and you break the pan without bringing up the subsoil to the surface. The pace of the plough, too, is of very great importance. With the horse-system, to plough for a show-field you must go extremely slow, that the furrow may be turned over without being broken; but with steam-power,

by driving the plough—say at the rate of three and a-half miles an hour—it is thoroughly broken, and the cultivation much forwarded.

I am inclined to think there is very little land in England that cannot be cultivated by steam. If the land is in ridges, I would recommend that it should be ploughed lengthways, and not levelled too quickly. I have a neighbour in Gloucestershire, Mr. Reed of Elkstone, who has an extremely hilly farm, some of which he says is as steep as the roof of a house; it is also bad to cultivate, from the many large stones in the field: yet he has worked it with steam very successfully.

The wear and tear of the steam apparatus would be principally on the clip-drum, the anchor, the rope, and the porters; and comparing it with horses, for harness, blacksmith's bills, shoeing, farriery, &c., I consider the wear and tear in the two cases to be so nearly the same in amount that I could scarcely say which cost most. But then, in addition to the other advantages which I have enumerated, the risk with the steam-engine is not so great as the risk with horses; horses are subject to all sorts of illness; they are often attacked with influenza, and frequently in the harvest time of the year I have known one-half my horses disabled and rendered unfit for work: not so with the steam-engine, which is always ready. You can also turn the steam-engine to account by thrashing, grinding, and doing other things during the winter, when your horses are standing idle and living expensively.

Now, I would by all manner of means recommend any gentleman who is inclined to embark in steam culture, at the first onset to buy sufficient power; for no more manual labour is required when you have 30, than when you have only 5 or 6 horse-power. Whatever be the working power of your engine, upon a rough calculation the power of four horses is consumed in the draught of the rope and friction, and this amount will have to be deducted from the force applied to the soil.

The question, then, in my opinion, resolves itself simply into one of 12 cwts. of coals *versus* the keep of 30 horses. You get your work done at the proper time. You have no ridge or furrow; for no water furrow is required. Drilling can be done in the same direction in which the land is ploughed; and this is a matter of very great importance, for I have seen one-third more of wheat grown in the same field, when it has been drilled the same way in which it was ploughed, than when it was drilled across the furrow. There is, moreover, a saving of seed, and you have no difficulty with the horse-hoe. I have been in the habit of having all my crops horse-hoed for years past. We use a Smith of Kettering's horse-hoe at the rate of ten acres a day with one horse: a most serviceable implement I have found it, deserving more notice than it has received. Having no furrows, we have no difficulty with the reaping machine; the one I use is Cuthbert's. Neither have we any difficulty with the mowing-machine (Burgess and Key's), whilst the carting can of course be done much better. You have yet this further advantage, no sheep die from being cast on their backs in furrows. By the use of steam, I believe summer

fallow will be entirely extinguished. Digging by the steam plough I regard as equal to digging by manual labour, the cost of the one being 5s. as against 2l. for the other. Again, rolling will not be required any more than it is required under spade husbandry; and the increase of crops I place at one quarter to the acre. The increase of stock kept must also be very great. In autumn you plough your land, and plant it with vetches or rye at one operation, which in the spring of the year you feed off in time for a root crop to follow; consequently your flock of sheep will be greatly enlarged, your root crop will be of much greater weight, and of better quality, and the land in a much better state for the sheep to lie on, being drier and more healthy for the animals than when it has been horse-ploughed. During the last three or four years I have found that the crop grown after the steam plough would come a week or ten days earlier to harvest, whilst the sample was in my judgment better and heavier. I have brought a sample with me from 400 sacks of red nursery wheat, which I have at this moment in my barn. And as to malting barley, whenever I have sold any I have always had the maltster sending to me again for more, finding that steam-ploughed barley was superior for malting purposes. The crops of seeds you will find to be wonderfully better, in consequence of the extra depth of cultivation. Clover that will hardly stand more than once in five or six years with horse culture, you have no difficulty in growing every three or four years.

Upon my farm I have a field of five acres that has been under grass for the last sixty years, and it has been valued at 10s. an acre. I have left it in the middle of my large steam-ploughed fields to show the difference between land under steam culture and that which is under the old system. In the two adjoining fields now under the plough we have the promise of five quarters of wheat to the acre at least. English farmers must in my opinion resort to the use of steam to maintain their position, for the foreigner will be sure to do so. If by the use of steam I can grow 600 quarters more annually, say at 38s. 4d. per quarter, that will amount to 1000l.

But the benefits accruing from steam culture do not end here; the improvement resulting to the labouring man is also very considerable; extra wages encourage emulation, and a desire is awakened to rise in the ranks; there is more time given for educating the boys, who are not required to come at so tender an age into the field.

With reference to the men in my own employ, my ploughman was formerly the ox-man; and the engine-driver formerly drove the thrashing-machine. During four years they have not lost a single day; I have had to make no change all that time; and the prejudice amongst the labourers against the steam-plough (for there was a great deal of prejudice amongst them at first) is now quite overcome. In fact they now take quite as much interest in its successful working as I do myself; it is my custom to allow them to knock off work on Saturday afternoon at four o'clock.

Some persons entertain mistaken notions with regard to the effect of a long rope. I find that the plough travels a few seconds faster from the engine to the anchor, say 400 yards, than from the anchor to

the plough. The extra power required, as tested by a dynamometer, to move the anchor was only half a horse-power, as the rope was running around the anchor 66 feet, and moving the anchor only one foot forward. Consequently it acted as a greatly reduced multiplier. The time required to move the engine forward and to turn the plough is only fifteen seconds, which is quicker than any pair of Scotch horses could turn.

The process of travelling the engine from field to field, or along the road, is extremely simple. We have never had any difficulty whatever; and I would as soon trust my men to take an engine from field to field as I would trust them with a one-horse cart. One argument which has been urged against the use of steam is, that if you do away with horses, you will not have sufficient to do your harvesting. Now, in the North it is the custom, the moment they begin harvest, to turn out half their horses, and use very few of them with carts; and if you make your ricks in the field, you easily get over that difficulty. I myself have had but eight horses on a fine harvest, and by making the ricks in the field they have been enough to cart the corn upon a farm of 800 acres. When ricks are made on the ground in the field during the summer months, the mice do them much less damage than when they are placed on staddles.

I would strongly recommend any gentleman who determined upon adopting steam-culture, not to cultivate too deeply or suddenly at first.

The Boydell system of travelling over the land is altogether out of the question, because of the large amount of power consumed to propel the engine, ploughs, &c., and the damage which is done by pressing the land. I would advise you to have ample power, for I find that sometimes in the same field I come upon a piece of clay, which requires double the power necessary to go through the adjacent gravel or stone-brash. Double power is also required where couch exists—a very good reason, I think, why couch should be eradicated.

Since I have mentioned Mr. Fowler's tackle, it is no more than justice to that gentleman for me to state in conclusion that I consider he is deserving of the very best thanks of the country for the skill and energy, as well as the large amount of capital, which he has brought to bear in carrying out steam cultivation to a successful issue. For my own part, I could not consent to return to the old system of culture upon any consideration. In fact, I would as soon pay rent for a farm, and use steam, as have a farm of my own for life under the old system. I look forward with confidence to the period when steam will completely finish all the operations upon the land at one time, and thus entirely abolish summer fallow. Seeing is believing; and although my farm is not the Land of Goshen, nor yet the Garden of Eden, if any gentleman in this room is inclined to embark in steam culture, and would like to see what changes I have made in my occupation, I shall be most happy to show them to him.

Mr. DENT, M.P.: As on Monday last I saw Howard's cultivator in operation at Bedford, and was pleased with the results, I should like

to make a few remarks in the hope that others will follow me. I should like to hear the opinion of practical men on the question, whether land should be ploughed or cultivated by steam. It strikes me that you will get more by the latter process than by the inversion of the soil. The difficulty of cultivating by horse-power is, that you cannot break up the land at a sufficient depth, nor shatter the rough clods in such a manner as to eradicate the weeds; steam gives us the pace and the power to do all this. You have then a better chance of cleaning your land, and rendering it available for the benefits to be derived from aëration and the water that falls upon it. Without in any way disparaging Mr. Fowler's system, which I have always regarded as most superior, I may say that at Bedford, the other day, Howard's cultivator, when working on a piece of strong clay land in wheat stubble that had not been disturbed since the harvest, and contained a good deal of twitch, thistles, docks, coltsfoot, and other weeds in abundance—went nine inches deep, travelled at a great pace, and turned up and broke the clods in a wonderful manner. Instead of cutting the weeds, as is done by the ploughshare, it turned them up completely. The only weed it did not shake out satisfactorily was the coltsfoot, which it is very hard to deal with at all on clay lands. Now, I should like to know whether, in the opinion of practical men, the cultivating system is not likely to a great extent to take the place of the system of inversion.

From what I saw of the crops in the neighbourhood of Bedford, I can quite believe that steam cultivation must largely increase the produce of corn, the wheat crops cultivated by steam appearing to be in a highly satisfactory state. With regard to the growth of clover, I should like to know whether other persons' experience agrees with my own. I find that there is no crop so difficult to grow as clover. This year, in one of my fields, there was a very nice plant all over it after harvest, but now except upon two acres it is entirely gone. The clover upon Messrs. Howard's clay land was exceedingly good; I never saw the plant better set, or thicker. Whether that arises from the land being better cultivated, or whether they have not grown it so frequently there, I am not prepared to say.

Mr. FREERE: Liebig, in his last work, the '*Laws of Husbandry*,' appears to regard clover as a deep-feeding plant, and to attribute its failure generally to the exhaustion of the available constituents of the undersoil. The statement of Mr. Ruck was therefore distinctly in accordance with Liebig's teaching, which was probably founded in truth, though it did not account for the going off the plant at an early stage of its growth.

The CHAIRMAN: I feel greatly obliged to Mr. Ruck for the information he has given us to-day on this most interesting subject. At the same time I would repeat the observation which I made some years ago, when Mr. Parkes's system of drainage was first introduced, that we must look to the different soils and situations, and the different state of the land, before we can lay down any rule for the adoption of one system or another. In the early part of his lecture Mr. Ruck stated that he put every drain into an open ditch, and I think I understood him to

say that his was a very tenacious soil. Now, some years ago, I myself adopted that system, for the sake of letting as much air into the drains as possible. Since that, however, I have had as few openings as possible; for I invariably found that if there was not sufficient water in a pasture field, the cattle would come down and trample the ditch, and so break up the drains: when these opened into a ditch the ground crumbled away. I understand from Mr. Ruck that he employs the same number of horses as before—that is 12, and has sold off 56 oxen, which is certainly a very great gain. The system of 14-horse power and heavy tackle is not perhaps suited to very hilly farms, especially where there are angles in the field. I quite agree that one of the first things that ought to be done is to enlarge your fields to the size of 20 to 30 acres. The subject of breakage Mr. Ruck has not mentioned. That which I experienced at the outset with Fowler's implement was very great, so much so, indeed, as to render its use most uneconomical. Since that, Mr. Fowler has sent me another set of implements, and I have had scarcely any breakages, excepting the eyes of the ropes, which are constantly coming out. Now Howard's ropes have no eyes. I have one of their cultivators also, and nothing can possibly do the work better. When steam cultivation first came in, I felt that Fowler's system of traction was the best, and that it ought to be engrafted upon Smith's mode of cultivation as it was then, which is now improved by Messrs. Howard, so that nothing can do better. The great advantage I find to be this, that when the ground is as hard as a rock, and it is impossible for any number of horses to do the work, I have with Fowler's diggers burst the land up 9 and 10 inches deep.

Mine is a 12-horse engine, but I cannot do anything approaching the quantity of work which Mr. Ruck mentions. From 2 to 2½ acres a-day with the diggers is as much as I have ever been able to accomplish, and about 5 acres with the cultivator. Mr. Ruck has also alluded to the drag, but he did not tell us what sort of drag he uses. I have recently employed a rotating harrow, which was sent me by Messrs. Ashby Smith and Co. of Stamford, and it is one of the best implements, when attached to a steam cultivator, that I know of. As I understand Mr. Ruck, his land does not require any rolling; but so far is this from being the case on my strong land, that I have never required so much clod-crushing and rolling to make my land a proper seed-bed for mangold as during this year. First of all I use Fowler's digger and then his plough; and, afterwards, I crush and recrush it with Howard's cultivator, using it at different times according to the state of the land.*

Colonel KINGSFORD, M.P.: Being a light-land farmer in Mr. Ruck's neighbourhood, I feel an interest in the opinion he has expressed that upon light lands the steam cultivation would pay better than

* Lord Berners explains that his cultivator (Howard's) draws in its wake on either side, a drag and a rotatory harrow, which are made fast by a chain to a long iron bar placed across the centre of the cultivator. When the land's end is reached, both drag and harrow are detached, and moved one or two feet aside. The cultivator returns between them, and they are again made fast and drawn nearly across the field.

upon heavy lands. In our district there is a large tract of hilly country called the Cotswolds, the soil of which is very light and very poor, and not more than 5 inches deep. Does he not think that the cost of steam culture on such land would very far exceed the cost of horse culture? You will remember that you cannot plough deeper with the steam engine there than with horse-power, on account of the character of the subsoil. At the farm connected with the College of Cirencester, the steam plough is used; but the soil there is deeper, and you can hardly call it the same soil as that of the Cotswolds, upon which light soil I have never yet seen a steam-plough in operation.

Mr. BRADSHAW (Chairman of the Central Farmers' Club) said, that he commenced the work of steam cultivation on the 15th of February, 1861, upon an occupation of 400 acres of arable land, in the county of Surrey, on the borders of Sussex, and he calculated that at the end of the present year his steam engine and tackle would all be paid for. The price per acre of smashing-up came to 4s. 11d. for the first operation; 4s. 3½d. for the second, and 4s. 1d. for the third. But the same work could not have been performed by horse-power without the aid of 12 horses, besides manual labour at the cost, as he calculated, of 12s. an acre. He formerly employed 16 horses; he now used 10, had his land under perfect control, and at the end of this year his steam machinery would be free. He was a warm advocate of smashing up rather than ploughing; indeed, he would never plough any land except red clover ley. He made this exception that he might have the full benefit of the under-growth of roots, which contained a large portion of carbon, and when decomposed furnished the best description of manure for wheat. He had this season made a comparative trial between land which had been merely smashed up and made fallow, and land which had been similarly treated and in addition ploughed for wheat. The wheat growing on the unploughed land looked much better than that whereon the plough had been used. The couch upon some of his land formerly measured a foot and a-half in length; yet not a particle of it was now remaining in the field which had been steam-cultivated twice. Yet he must venture to limit the use of smashing up, though he knew he stood in opposition to Mr. Smith, who was, in fact, an enthusiast. He would not advise any man to smash-up his land with steam tines in the autumn, unless he did it early enough to eradicate perfectly and destroy the weeds. He would rather plough 3 inches deep, and smash-up in the spring with a steam-cultivator; then he should obtain the finest preparation for swedes or mangolds that he could desire, and that he had done this year. His land was of various descriptions; some very heavy (much heavier than the land about Bedford referred to by Mr. Dent); some very good light friable land: where there was heavy land they had had to go slower, the resisting power being greater; and where there was light land they might employ steam-culture with equally beneficial effect, because all they had to do was to extend their implements, and thus they would break up more land.

Mr. DENT: What was the effect upon light-land crops?

Mr. BRADSHAW had lately visited the light-land farm of a neighbour,

to see how he succeeded with Howard's new implement, when he was informed that last year, upon the land smashed up and not ploughed, a quarter and a-half more of barley was grown per acre than when the plough was used. He inferred that by the use of the steam cultivator crops of every description would yield something like twenty-five per cent. more than where the plough had been employed, and to that extent increase the produce of the land. He had begun with Smith's tackle, and was now using Howard's by way of experiment. He had been perfectly satisfied with Smith's, but should be glad to get better if he could do so.

Mr. SIDNEY had visited Mr. Ruck's farm more than once, and observed that he had the advantage of having a liberal landlord, and a fine road ran through the estate; whilst Mr. Ruck himself was a man of an enterprising spirit, which enabled him to make the best use of these advantages. It would be universally agreed that we had now arrived at that point in the history of steam cultivation when it was no longer a matter of theory but of practice, and there was no intelligent farmer occupying a sufficient tract of a retentive soil but would be happy to avail himself of its use if he had it in his power. Mr. Ruck had remarked that it was necessary that those who entered upon steam-culture should have something more solid than a six months' tenure to depend upon; but it was not in the power of every landlord to give security of tenure, or to embark in such a large expenditure as the construction of roads required. Good roads would now become of the same importance to a farm as good drains; but, in the mean time, those who had not good roads must avail themselves of that description of machinery for cultivation which did not require them, and at the present moment it seemed as if the advantages were pretty evenly balanced between Fowler's and Howard's implements; the former having more power, whilst the latter dispensed with the necessity for good roads by cultivating from one corner. Landlords and tenants have both availed themselves of Government loans and the assistance of Land Drainage Companies: without this resource the improvement of systematic drainage would never have made the progress it had. If farmers were to adopt steam cultivation generally, they must have Steam Cultivation Companies ready to lend this valuable but expensive machinery for long terms.

Mr. HOLLAND, M.P., in moving a vote of thanks to Mr. Ruck, observed that steam cultivation was still so much of a novelty that it could not be expected that any very general rule could be laid down for its application to any particular soil. In common life a well-educated medical man never dreams of applying his professional skill until he has felt the patient's pulse. Just in the same way steam cultivation must not be applied to any particular field or farm until its peculiarities have been ascertained. He could not on his farm do without turning over the land, because his land was very heavy, with a high ridge and a furrow that must be brought down considerably before he could cultivate properly. To get all the advantage of climate and rainfall, the land ought to be comparatively flat; and it took many years, and great patience, before that could be accomplished; much care being required not to turn over too rapidly, or

until the subsoil brought up to the surface had been thoroughly aerated and chemically changed. But the day might come when some one else after him would continue steam cultivation; and then, after the land had been made comparatively flat, would arise the question whether, seeing there was a large amount of soil aerated to a great depth, the plough should not give place to the cultivator. Upon the land at the College of Cirencester, spoken of by Colonel Kingscote, there was a large body of clay, but the adjoining land was originally stonebrash, no doubt more or less blended with its neighbour. All beyond that, however, was stonebrash; and as Mr. Bradshaw had remarked, although they could not go deep there, it was a great advantage to be able to take a large area with the machinery in the course of a day. The changes which took place in the course of cultivation were curious. Although he had been obliged, in the first instance, to supply himself with a large amount of steam power—say from 12 to 14-horse power, yet, after the heavy land had been gone over two or three times, the engine could be worked with less power, but a power that would still suffice for all other operations on the farm. One of the objections, indeed, to employing the large 14-horse power engine in thrashing and other operations in connection with the farmyard, was that they consumed more coal and used more power than they needed. After they had got their fields into deep cultivation, therefore, a less powerful engine than they required at first would answer their purpose, and he himself was now working fields at a pressure of from 55 to 60 lbs. the square inch, whereas in the first instance he had worked at from 80 to 85 lbs. There is great economy in the employment of steam even now, and if in the course of time an engine such as can economically do the thrashing and other work in the farmyard becomes sufficient for cultivation also, the gain will be very great. Much good may result from the formation of Companies, because it was the want of money that has hitherto prevented steam power from being generally applied by the tenant farmers to the land. Mr. Ruck had led the way—and as he said it was the habit of farmers to follow one another like sheep through a gap—he did not think they could have a better bell-wether than his friend. He would only add, in repeating his thanks to Mr. Ruck for his able lecture, that the Royal Agricultural Society was moving in the right direction when such a question as this was introduced by a tenant farmer, and followed by a discussion in which other tenant farmers had borne a part.

Colonel KINGSCOTE seconded the vote of thanks.

Mr. RUCK, in acknowledging the vote of thanks, remarked that the cost of steam culture with drag attached upon strong land was only 5s. an acre, and that fact he wished to stick in the gizzards of the light-land Gloucester farmers. He owned he was surprised to hear the noble Chairman say that he could only do 2½ acres of digging per day. Now, the digging and the ploughing were of the same width; and unless something very extraordinary took place, he could not see but that the noble lord had sufficient power to do six or eight acres upon any land. With regard to breakages, he could only say that his bailiff had that morning put an account into his hand of 222 acres

ploughed, 437 acres dragged, and 247 acres scarified; and all that work has been done this year with one engine without breakage to the extent of a single sixpence. As to the remarks of Mr. Bradshaw about the comparative merits of smashing-up and ploughing, according to his (Mr. Ruck's) experience this year, the land that was tilled with the digger for wheat was beating the land that was ploughed. If it was intended to go an extra depth, he thought the land should be ploughed and left exposed for the frost of winter. He had no doubt, however, that smashing-up for barley was better than ploughing.

Meeting of Weekly Council, Wednesday, June 10th. Lord BERNERS, Vice-President, in the Chair.

THE BREEDING AND FEEDING OF SHEEP.

Professor COLEMAN, of Cirencester, introduced as the subject for consideration, "The Breeding and Feeding of Sheep, with a view to increasing the sheep-stock per acre."

Mr. COLEMAN said: The subject I have the honour of introducing for discussion this morning is one of, perhaps, equal importance with that which so lately occupied your attention, viz., "Steam Cultivation;" for the successful development of either must tend to the same result, viz., the more economical, because more abundant, production of corn. It is hardly necessary to point out that the history of prices during the last few years leads us to anticipate that corn must range at very moderate rates,—rates which would formerly have been considered ruinous, but which, thanks to our increased resources—thanks to the great stimulus which competition has produced—we can now look forward to without despair. One great lesson taught us by our experience is, that we need not henceforth look only or principally to our cereal produce, but must endeavour to draw our returns from an increased growth of meat. It would be interesting and useful to have statistics as to the number of sheep, horned stock, &c., bred in the United Kingdom; in the absence of these, we can only draw general conclusions from the prices that are realised. The scarcity of meat during the last few years, and the very high prices obtained, would lead us to infer that production does not keep pace with the increase of population. It also shows that in this branch of our produce we have little to fear from foreign competition. That live stock, and especially mutton, cannot be imported to any considerable extent, the following figures, taken from the accounts relating to trade and navigation for the last three years will amply testify:—

MONTH OF DECEMBER.

	1860.]	1861.	1862.
Sheep and lambs	76,726	89,294	56,276
Oxen, bulls, and cows	16,785	15,076	14,555
Calves	5,938	4,005	4,782
Swine	4,417	8,293	1,277

YEAR ending 31st DECEMBER.

	1860.	1861.	1862.
Sheep and lambs	320,219	312,923	299,472
Oxen, bulls, and cows.. ..	77,010	81,194	68,818
Calves	27,559	25,902	29,069
Swine	24,452	30,308	18,162

Supposing that the live weight of each beast is equal to that of ten sheep, and that of each calf to two sheep, the weight of horned stock imported is double that of sheep; and we have the importations steadily declining from 1860 to 1862, notwithstanding that prices of meat ranged high during those years—mutton by the carcase making from 5*d.* to 6½*d.* per lb. It would be equally easy to show that the British Isles are naturally adapted, beyond most other countries, for the production of meat, when we consider the effects of our moist and changeable climate in rendering all the strongest land along our western shores suitable for pasture, and enabling our dry uplands to carry forage crops. It is for us to consider how we can best make use of these natural advantages, and adapt our system to the altered conditions that surround us. On the one hand, we are told to lay down our land to grass; on the other, to give up corn-growing, and substitute crops that afford sheep food. Where land, owing to soil and climate, is especially adapted for grass, it may be profitable to lay it down, though there is very little grass land that pays without a considerable proportion of arable land to work with it; and we should often act wisely if we adopted a more generous treatment of the existing grass land rather than added to its extent. No portion of our acreage is more grateful for judicious outlay.

It may be well here to state that in laying down land to permanent pasture much evil has resulted from injudicious grazing with sheep. Close feeding by heavy or old sheep will destroy the clovers and finer description of grasses, and with a cropped surface root-growth is impossible. As well might the forester expect to grow timber if he closely pruned off all the branches from his trees. Manuring with composts of well-decomposed manure and soil, mowing the grass when young, and afterwards grazing with lambs and calves, will produce a finer and thicker sward in a shorter time than by any other plan.

Those who would have us abandon corn-growing have never accurately considered how far live stock can be made to pay for the crop they consume. Finding, for instance, that sheep produce a large gross return, they are apt to consider that this is all profit; whereas it is not difficult to show that sheep alone, apart from their influence on the corn crops, will not pay a living profit after all the expenses of growing the crop which they consume are considered. Thus, a tag in good condition, of the long-wool breed, will be worth 40*s.* on October 1st. From this to the 1st of April—183 days—it will consume about ½ lb. of oilcake a day, at a cost of about 8*s.*, and 1½ tons of swedes, at 8*s.* a ton, 12*s.* Add to this, attendance 2*s.*, interest of

money 1s., 5 per cent. of loss, about 2s., and we have a total of 65s. which represents a full value for carcase and wool. If we made a similar calculation for breeding sheep, the return would apparently be much greater; but if the greater risk which attends it be taken into consideration, it is very doubtful whether, apart from the growth of corn, even breeding sheep would return a living profit. Moreover, we know that there is a limit to the extent to which we can stock and crop land; therefore, if we regard the subject in all its bearings, it is clear that on arable land we cannot profitably abandon the growth of cereals. We may possibly so alter our system as to have corn less frequently on the same ground; but such alteration must be made with a view to an increased produce per acre. The point, then, to which I would draw your attention, is to a more economical system of feeding sheep, especially breeding-sheep, so as to increase the returns, and at the same time leave the land in better condition for corn. This result would, I believe, be effected by reducing the quantity of roots, and using more dry food, such as straw, in combination with a small quantity of artificial food, which will act as a stimulus to digestion. By these means we shall have the land in a much richer condition for corn, because the sheep will take a much longer time to consume a certain weight of roots, and the animals will be in a better condition. It is calculated by Morton and others that a breeding ewe will consume one-fourth of its live weight of turnips, or 20 lbs. to 30 lbs. a day, of which nine-tenths is water. This food during winter is often very little above freezing point, and it follows that much heat will be absorbed, and consequently food wasted, in raising this volume of water to the temperature of the animal's body. By water within, and often water without, the temperature of the body must be greatly reduced, and we are not surprised that with such an unscientific mode of feeding the animal cannot maintain its condition, and is unable to minister to the wants of the foetus. The latter is often chilled, and born dead, especially from young ewes in a wet season. Now, if we can reduce the quantity of roots one-half, and substitute an equivalent in the form of straw and condimental food, at the same time attending to the external comfort of the animal, we shall have achieved a great point. The land will be doubly manured, straw will be made more of than when trodden solely into manure, and a greatly increased number of sheep can be kept upon a given weight of roots. It is only of late years that the feeding value of straw has been ascertained or believed in, and even now there are many who consider it only fit to be trodden into manure. That the quality of straw varies much according to the nature and condition of the soil, and more according to the way in which it is harvested, no one will dispute; but there is abundance of evidence to show that when cut comparatively green, and carefully managed, many kinds of straw are exceedingly nutritious. This is a truth which the tables before you sufficiently illustrate; but further, from personal experience, I am fully convinced that good straw may be economically substituted for hay in the winter feeding of sheep, even without any artificial food, though the cost of the latter, as I trust to be able to show, is so slight that it can be economically employed.

The following calculations will show the effects, both on the land and the animal, resulting from this system:—

An acre of turnips = 15 tons.

Amount of nitrogen left in manure made from turnips, 74 lbs.

Amount of mineral matter, 800 lbs.

The analysis of the mineral matter gives:—

Per Acre. lbs.		
110·94	Potash	36·98
20·28	Soda	6·76
1·77	Chloride Potassium	·59
23·55	Common salt	7·85
10·83	Magnesia	3·61
33·42	Lime	11·14
29·22	Phosphoric acid	9·74
37·29	Sulphuric acid	12·43
10·29	Silica	3·43
3·27	Iron	1·09
19·14	Carbonic acid	6·38
<hr/>		
300·00		100·00

Such would be the manuring value of an acre of turnips consumed by sheep eating 20 lbs. of roots daily, with no dry food. If we substitute $1\frac{1}{2}$ lb. of straw for 10 lbs. of turnips, it follows that with every acre of turnips 2 tons 4 cwt. of straw will be eaten. Straw on an average yields $\frac{1}{2}$ per cent. of nitrogen; therefore 2 tons 4 cwt. = 24·6 lbs. nitrogen, of which 21·6 lbs. is left as dung, probably about one-eighth part being consumed in exhalation from the animal's skin, &c. The same quantity of straw will yield 221·1 lbs. of mineral matter as manure. Of this a considerable portion, about 48 per cent., is silica; but the remainder contains minerals which are very valuable as plant food. The addition to the soil of this large amount of silica, in round numbers about 107 lbs., in a condition available for plant food, would act beneficially on the following barley crop, which requires, for grain and straw, more silica than any of the other cereals.

Analysis of Ash of Oat-straw.		Quantity returned per Acre as Manure. lbs.	
Potash	19·14	.. .. .	42·29
Soda	9·69	.. .. .	21·41
Magnesia	3·78	.. .. .	8·35
Lime	8·07	.. .. .	17·83
Phosphoric acid	2·56	.. .. .	5·65
Sulphuric acid	3·26	.. .. .	7·20
Silica	48·42	.. .. .	107·00
Peroxide of iron	1·83	.. .. .	4·04
Common salt	3·25	.. .. .	7·18
<hr/>		<hr/>	
100·00		220·95 lbs.	

We may fairly calculate that by giving ewes $1\frac{1}{2}$ lb. of straw per day we increase the value of the manure by more than one-half. Many of

the root crops grown for breeding sheep do not reach to 15 tons per acre, in which case, according to the common plan of feeding off, the sheep run over the ground so rapidly that a good dressing of manure cannot be left behind, and hence we fail, comparatively, in one of the most important objects for which we keep sheep. The use of dry food remedies this defect.

Let us next consider how far straw compensates the animal for the loss of half the turnips. Fifteen tons of turnips will yield nearly 3024 lbs. of dry matter; 2 tons 4 cwts. of straw will yield 4233 lbs. The proportion of this latter that would be digested is a point on which, unfortunately, we have no very precise data. A series of carefully-conducted experiments to settle this question would be very valuable. Much depends upon the condition of the straw, as the following tables will show:—

ANALYSIS of OAT-STRAW, calculated dry.

	I Green.	II Fairly Ripe.	III Over Ripe.
Oil	1.68	1.25	1.49
Soluble protein compounds	6.56	3.13	1.54
Insoluble protein compounds	3.54	1.74	2.79
Sugar, gum, mucilage, &c.	19.07	12.59	3.78
Digestible fibre	31.36	35.92	33.04
Indigestible woody fibre	29.70	37.84	49.80
Soluble mineral matter	6.86	4.31	2.70
Insoluble mineral matter	1.23	3.22	4.86
	100.00	100.00	100.00

You will observe by reference to the analysis that the proportion of sugar, &c., differs immensely, and that of soluble and insoluble woody fibre differs considerably, according to the condition of ripeness. The chemist infers that what he calls digestible woody fibre (as being soluble in dilute acids and alkalies—similar re-agents, as far as he can judge, to the gastric juice and biliary secretions) would be converted by the digestive process into food, and that all that resists such tests will pass through the system, being insoluble. It is highly probable that this is so, and that the digestive system of the animal is even more powerful than these chemical reagents. From my own experience of the effects of using good straw, I should consider that from half to three-quarters of the dry matter would be available as food. Supposing, however, for the sake of argument, that only one-half this dry matter of the straw is available, whilst the whole of the dry matter in the turnips can be made use of (which is never absolutely correct, since in full-grown turnips there is about 3 per cent. of woody fibre, and when the plant is over-ripe, especially towards spring, when the flower-stem is shooting, a much larger proportion of insoluble matter), we have the straw yielding 2116½ lbs. of available food, against 3024 lbs. in the turnips; and it follows that sheep eating turnips and straw, and thereby econo-

missing the consumption of the root crop one-half, consume in a given time 5140 lbs. of dry matter, against 6048 lbs. when feeding solely on turnips. Surely this difference will be partly compensated by the healthier condition of the sheep, and by the lesser amount of fuel required to maintain the heat of the body when less cold water is taken into the system. Scouring, which in bad weather is common to ewes eating only turnips, is rarely seen where straw is consumed. I am satisfied that on the Cotswold Hills breeding sheep may be kept up to or near lambing time in a healthy, thriving state, by the use of straw. The addition of a very small quantity of artificial food would doubtless prove a good investment, both as regards the land and the animal, enriching the manure to some extent, but acting principally as a stimulus to the digestive powers of the animal. The cost per head would be very small. Thus, 100 sheep would take 33 days to eat off 15 tons of turnips, as proposed, and if supplied with $\frac{1}{4}$ lb. a-day of artificial food, would eat 825 lbs. The food would cost probably about 8*l.* a ton, and might be thus composed—

	£.	s.	d.	
$\frac{1}{4}$ of rapecake or nutmeal, at	7	0	0	per ton.
$\frac{1}{4}$ of beans, peas, or lentils, at	8	10	0	"
$\frac{1}{4}$ of Indian corn, at	7	0	0	"
	3)22 10 0			
	<hr/>			
Cost per ton	7	10	0	
To which might be added—				
Fenugreek 9 lbs.				
Aniseed 6 lbs.				
15 lbs. at 8 <i>l.</i> per lb. ..	0	10	0	

Cost of compound 8 0 0 per ton.

Nutmeal is a comparatively new feeding article, which is valuable chiefly on account of the large proportion of oil it contains, which varies from 16 to 25 per cent. It is the meal produced from the manufacture of oil from the palm-nut-kernel, and is principally sold by A. Smith and Co., Liverpool. The present price is 6*l.* a ton. Beans, peas, or lentils, all closely analogous in composition, contain 24 to 26 per cent. of nitrogenous compounds, and hence are very suitable for growing stock when given in small quantities; and crushed Indian corn contains much fattening matter, so that a meal composed of these ingredients is both cheap and nourishing. The addition of the comparatively small proportion of fenugreek and aniseed gives a flavour to the whole, and acts as a tonic to the digestive system. The cost per acre of the artificial food is 2*l.* 19*s.*, of which outlay a considerable portion is repaid in the manure. The total quantity of artificial food consumed by 100 sheep during six months amounted to 2 tons 2 qrs. 14 lbs., or 3*s.* 3*d.* per head. Of this, one-third will be returned in the increase of wool, especially in long-woolled sheep, one-third left as manure, and one-third will be paid for in the improved condition of the ewes and lambs. Two years since, wishing to economise the roots,

we supplied our young ewes with a quarter of a pound a-day of nutmeal, with chaff, and a very small quantity of roots, and they thrived wonderfully.

METHOD OF USING STRAW.

Having, then, endeavoured to show that straw may be economically used with roots for sheep, I will next point out how it can be best supplied. It is customary either to give straw long, in racks, or to cut it all into chaff. The latter plan does not answer, as bad and good straw are so mixed that the animal refuses all, and the expense of cutting is not paid for. The former plan is by far the best, when the straw can be thrashed and stacked in the same field where the roots are being consumed. Nothing can answer better, unless it can be shown that a system of pulping roots and cutting chaff can be economically carried out. I have the experience of a very good flock-master in support of this plan. Three hundred ewe tugs go first, and are supplied with hay; 600 ewes follow, eating the remains of turnips and some straw; these lie back at night on a foldyard, kept well littered by the refuse straw removed from the racks. It is surprising what a large quantity of straw may thus be consumed, with what a small quantity of turnips the ewes will thrive, and what a rare manure-heap results, which is close at hand to be spread on the young seeds the following autumn, with the minimum amount of labour. A system of this sort is well suited to large breeding-farms, where the land often lies remote from the buildings, and the consumption of straw in the homestead would greatly increase the labour. Straw should be used in the following order:—Good sweet barley-straw first; this may be commenced when ewes are eating mangold-tops, &c., and will last till November. Then oat or bean straw, the latter being most valuable in cold weather; and lastly, pea-straw, which, when well made, is equal to much of the seed hay grown on light land; with this may be given a portion of hay when ewes are lambing. Our practice is to build a good stack of freshly-thrashed pea-straw in the ewe-pen, often so as to form a wall of division, and to fodder once a day with this, and once with hay. Sheep thus fed will be most conveniently managed with nets, instead of hurdles, as less work is required in setting a fold; and the turnips should be first picked up, at a cost of 1s. 6d. an acre. Where ewes are allowed a full quantity of turnips, and the crop is a fair average one—say 13 to 14 tons per acre—the common rule is to allow one hurdle to each sheep. Thus 100 sheep require daily 10 hurdles square. This applies to large-framed sheep.

PULPING STRAW AND ROOTS.

We have now to consider whether any system can be economically arranged for pulping the roots and mixing them with straw and chaff. We all know what a great improvement has taken place in the feeding of horned stock by the use of the pulper—how animals that formerly consumed from 1½ to 2 cwt. of roots daily, when sliced, are now better fed on 70 lbs. to 80 lbs., with 15 lbs. to 20 lbs. of straw. Shorthorn cows dried off previous to calving, being in an identical condition with

the breeding ewe, are kept in a good store state upon from 25 lbs. to 30 lbs. of roots with straw. The digestive apparatus of sheep is very similar; and yet, though only one-tenth the weight of the cow, we find ewes still eating 20 lbs. to 30 lbs. of turnips almost without dry food. Surely we have here evidence of an extravagant system. The difficulty lies in carrying out the plan economically. Many will say that the labour is too great, and that breeding sheep so treated will not pay for attendance. In reply, I would ask, what proportion does the cost of consuming bear to the cost of growing? An acre of swedes can seldom be produced for less than 5*l*. To clean and cut up the same, according to our present system, would not exceed 1*l*. If by doubling the expenses of feeding you can double the number of sheep kept, as many sheep can be fed for 3*l*. 10*s*. as under the old system for 6*l*. That breeding-sheep will readily eat food so prepared I have proved by experiment, and that they must thrive much better on such a mixture than on roots alone is also certain. I would sketch out for your consideration the following plan:—The crop should be stacked in a convenient position, and when it has been thrashed, the straw, &c., should be again carefully stacked and thatched; roots should be cleared and laid in large heaps and at such distances apart as will allow of sheep lying two days on the same ground; use a combined pulper and chaff-cutter on wheels, worked by horse-gear; a light roomy house on wheels, with canvas sides, to store mixture for second day's use; four days a-week one horse and a lad will be employed extra; a load of straw, first carted from stack to heap of roots, then the two cut up, the produce of morning's work being used for the day's food, that cut later in the day stored away in house for the following day. Messrs. Samuelson and Co., of Banbury, inform me that they make machines of the kind referred to, which, worked by two men, will turn out 100 bushels of the mixture per hour. I merely advance this idea in the hope that it may lead some competent judges to state their opinions. I think it would do best on dry healthy land; but where a considerable percentage of clay exists, the land is at times so sticky and wet that a good lodging at night is of the utmost importance; in that case the sheep thrive best when lying back on a well-littered fold, supplied with straw in racks. Whichever system may be found most paying, whether pulping or gnawing, the health of the animals will be maintained and food economized by supplying them with dry lodgings.

Before the ewes go to the lambing-pen they should be dressed with a solution to destroy lice and ticks, and prevent all rubbing. The best plan is to have a double line of eight to ten hurdles set up, four feet apart, at each end more hurdles at right angles, so as to form places for entrance and exit. The ewes draw in and stand so close together that they are easily handled by the attendants—three in number,—one holds the sheep, another attends to the liquid, and hands it to the third, who, with an old tea-pot or similar vessel, with a spout, pours the solution along the back from head to rump, three times backwards and forwards, one pint of liquid to each sheep. The more quiet ewes can be kept during all stages of pregnancy the better. Instances have occurred of abortion at three weeks from fright caused by a dog.

Later on, the necessity for quiet is increased. Only last lambing we had an instance of this. The ewes, when within a few days of lambing, were disturbed by some students, who tried to catch them, and numerous dead lambs and cases of false presentation resulted.

In breeding it is always desirable to use first-class rams. The males should be of higher quality than the females; but more especially is it important to select the very best animals to put on young ewes, for the character given to the first produce will often come out again. About this there cannot be the least doubt. With regard to the proportion of male and female lambs, and the fall of double or single lambs, it has been supposed that the condition of the parents at tupping influences the result. Young vigorous rams will get the larger part of their stock male; doubles depend very much upon the condition of the ewes. If ewes are poor and doing badly, doubles will be scarce; if in good, hard condition, and rather improving, we may expect more doubles. The nature of the farm as affecting the quality of the food has also a good deal to do with this.

MARKING RAMS—THE WASHPOOL.

The plan of marking the breast of the ram with ruddle is convenient, as enabling us, by alteration of the mark, after three weeks, to draw out the forwardest ewes for the pen. The ram remains for six or eight weeks; after which the barren ewes may be withdrawn, being proved by a teaser marked a different colour.

Where a convenient washpool exists on a farm, it will be found very desirable to swim the ewes occasionally, though of course, unless great care is exercised, this might be attended with risk when they are in lamb. Their skin is apt to become dry and harsh; the water cleanses the pores, and encourages circulation through the skin, and consequently relieves the central organs, which are always more or less taxed in sheep. In the case of fevers, especially when these result from hard keeping, swimming will prove most advantageous. From eight to ten days should always elapse between washing and shearing, in order that the yolk may rise.

FOOD AFTER LAMBING.

The ewes after lambing continue on turnips and swedes. Good crops of the former may be obtained after early vetches. At this time the proportion of dry food must be lessened, and a few mangolds introduced. Lambs soon learn to run through lamb hurdles and may have a fold ahead supplied with a small quantity of artificial food, consisting of pounded linseed-cake, bruised oats, pot bran, and malt combs, in equal proportions. The quantity consumed will be very small, as the great object is to teach them to eat, so that when owing to a change of food the lambs require better treatment, no time may be lost. The management of the young lambs for the first five or six months is the most difficult. They are very susceptible of unfavourable influences, and bad food for two or three days only will often permanently check their growth. As soon as the root crop is cleared off, couples go on

to seeds, which are folded off. Two plans may be followed, either to keep the ewes in close quarters, having a lamb-pen a-head, and shifting often twice a day, or else to let them lie back on the ground they have already cleared. The first plan is best for the keep in dry weather, but does not do so well for the ewes which have a better lodging when allowed more range. Still, by the first plan, land is evenly fed off and manured. Lambs must never lie back, as the young shoot of clover and ryegrass is sure to produce scour from its unripe state. Mangolds cut up in troughs for the ewes at this time will be very good food. The seeds should be mown, if possible, after being fed, even should the crop be light. This is more especially desirable when we have mixed seeds, clover, ryegrass, and hop trefoil. The sheep do not thrive nearly so well when feeding a second time over. The clover often disappears to a great extent, especially if it has been fed very hard. Mowing sweetens the surface, and the next time, if it be reserved for the lambs, the bite is good, and they do well. There is a difficulty with the seeds on much land. Clover will not grow every fourth year. Too much ryegrass, especially Italian, is injurious to the wheat crop, and is not always good food, being inclined to rankness on good soils.

MR. RIDLEY'S SYSTEM.

The system practised by Mr. J. Ridley, of Damersham, Salisbury, on his light-land farm situated on the upper chalk, is worthy of notice. He farms strictly on the four-course shift, and sows broad clover alone only once in 12 years; for the other layers he substitutes 16 lbs. of hop trefoil and 8 lbs. of white Dutch. The latter are principally, if not entirely, fed; the very different habit of growth of the two plants is favourable, as the trefoil affords an early feed, and the white Dutch is just in flower for feeding the second time. I am informed that his lambs are very superior to any in the neighbourhood. The cost of such a crop, about 10s. an acre, contrasts favourably with that of winter vetches, although the latter is an extra crop, which may be followed by good roots. I should have feared that such a large quantity of white clover would have scoured the lambs. A careful system of close feeding would be the best thing to prevent this. In our own case we have found lambs thrive better on vetches than on seeds, and I have for some years weaned on vetches, leaving the ewes on seeds, though some would think this objectionable. The customary practice is to leave the lambs where they are, and remove the ewes, or, as in Wiltshire, leave both, merely separated by a double line of hurdles.

If by the use of straw, either pulped or long, we can increase our winter keep in anything like the proportion I have named, we shall want both seeds and vetches to carry us along through the spring and summer.

WEANING AND DIPPING.

Early weaning will be found generally desirable, say in the second or third week of May. Lambs that drop in February will then do

best without their mothers. As soon as possible after weaning they should be carefully dipped. Biggs's dipping-trough and composition are both excellent. We should dip twice or thrice during the season; the outlay (under 2*d.* a head) will be well repaid in improved health, freedom from irritation, and so forth.

Change of food is desirable for lambs; hence vetches and clover can be alternately fed; next rape and vetches mixed; then rape, which may be got ready for August; early turnips and rape in September. Sainfoin is also very valuable as a change. On regular breeding-farms, especially when the climate is against winter-feeding, lambs should be sold in the autumn. They will often make a comparatively higher price than if kept through the winter and fattened. There will always be plenty of buyers, because so many farms are unsuited for breeding.

It is probable also that fattening sheep in yards will be a more common practice when the profitable character of the system, as compared with feeding cattle, has been more fully demonstrated. Some time ago, a paper was read at the Central Farmers' Club by Mr. Ruston, in which that gentleman stated that 6 lambs tread as much straw into manure as a beast; that one acre of mangold kept 25 sheep from December 1st to April 15th; and that he made his mangolds pay 12*l.* 11*s.* 2½*d.* per acre, and the hay and straw 3*s.* a head. Hence we may look for an increased demand for good stock tags, such as ought to be produced by the kind of feeding we have sketched out. With regard to the proportions of food for say 200 fattening and 100 store tags, the summer keep would consist of clover, vetches, and sainfoin; and they should be always folded, and the sheep changed as frequently as possible. For August we must provide 8 to 10 acres of rape and vetches. A most excellent mixture is 1 bushel of vetches and 2 lbs. of rape; a feed of clover-hay should be given in the morning, and a feed of rape in the afternoon, when their bellies are full, with a little hay and ¼ lb. of corn. From September 1st to October 15th, 10 to 12 acres of rape planted at two or three times will be required. From the middle of October to December 1st, 10 acres of turnip cut for fattening sheep. From December 1st, swedes: a good crop will last the 800 sheep one week. By Christmas increase the corn to ½ lb., and later on from ½ lb. to 1 lb. Lambs, when first fed on the roots, are sometimes affected with scour of a peculiar character, and die off very suddenly, though at first they may appear to be doing remarkably well. In these cases the roots are generally fleshy and growing. The sheep have abundance, and were probably poor when put on. The cause of death is apoplexy, or making blood too fast. The blood becomes thick and unhealthy, and the animal dies. Corn, given injudiciously, will produce the same result. If the sheep is supplied with corn undiluted with chaff early in the morning, when the belly is empty, it will eat ravenously, and suffer accordingly. Chaff is so valuable a diluter of corn that some old shepherds, though doubtless with some exaggeration, say that a pint of corn with a pint of chaff is equal to one quart of corn given alone. Chaff, with roots, if the application could be economically carried out, would undoubtedly be far better food, espe-

cially during the depth of winter, than a very large quantity of roots.

In the very brief sketch which the time allotted enables me to make, you will observe that I have not touched upon several matters of interest and importance, such as the value of the different breeds of sheep—in itself a most comprehensive topic. I will say no more, however, than to thank you for the attention with which you have listened to my observations.

Lord BERNERS (the Chairman).—I am sure the meeting will be of opinion that most of the suggestions that we have heard from the Professor are of the highest value and importance. I can state that I have for many years carried out what he has recommended with respect to dry food both for cattle and sheep, and have found that when I reduced the quantity of turnips given to bullocks and sheep, and supplied them with a certain proportion of cut straw, they have done a great deal better than they did before. An ignorant common labourer will often give his bullocks as much turnips as they will eat, whatever be their condition at the time. One day, I found in a yard twenty or thirty bullocks tied up and shivering dreadfully. I asked the man in attendance what was the cause of this? and he replied, "Oh, yes; they always be so after eating so many turnips." I at once ordered the quantity of turnips to be reduced, and gave the animals dry food, and there was no more shivering afterwards. With regard to cutting hay and straw, I do it entirely by steam. I pulp the roots at the same time, and experience the greatest advantage from it.

Mr. Coleman has alluded to the couples depending very much on condition; this I found to be the case a great many years ago. When residing in Norfolk, I had about a thousand ewes on the high lands, and we were short of food; but, happening to have some coleseed on the land which I had brought into cultivation, I sent the thousand ewes to feed upon it, and we had not only a greater number of lambs than before, but the ewes, as the shepherd said, came quickly into use. My lambs acquire the habit of eating artificial food before they are weaned, otherwise there is a difficulty in inducing them to eat it at the time of weaning. Though the quantity given is but small, yet it is a means of keeping them in good condition until the cold weather comes. In my neighbourhood it is not the practice to give lambs artificial food until cold weather arrives, and I have seen them at that season half-dead and hardly able to move; but the instant you give them this stimulating food they die off more rapidly than before. I think, then, it is of the greatest consequence to keep all stock going on with such a supply of food as prevents their being enfeebled and chilled.

Mr. Coleman's observations upon the different kinds of straw are also very valuable; and here I may mention a fact which some of the gentlemen now present may remember. Some of you may recollect how successful Mr. Grantham was at the Smithfield

Show thirty years ago with his Southdowns. I visited him on several occasions before this Society was established, and I found his ewes in the yard in the winter, supplied with nothing but pea-straw; and he assured me that they were thus kept healthier than they would be in any other way. Well, I tried the system, on a small scale it is true, because I grew very little peas; but it proved to be so beneficial, that I have almost invariably kept a stack of pea-straw since, and given it to the ewes when they were lambing. The Professor has also referred to bean-straw. I had never used bean-straw, from having been informed that it was likely to cause gripes, until two or three years ago, when there was a great deficiency of fodder. I was told, moreover, that it was not good for cows, because it would dry up their milk. I then had the bean-straw cut and steamed, and I certainly never found my horses, cows, and other cattle do so well on any mixture of straw and hay as they did on bean-straw so cut and steamed. I lay great stress upon it being steamed, because it is otherwise so hard. I do not think that during the short time it remains in the animal's stomach much nutriment can be abstracted from it, unless it is half-digested by steam. I would now beg to offer the Professor the best thanks of the Society for his excellent lecture.

Mr. HOLLAND, M.P., had tried a mixture of chaff and cut hay with roots, and had found the economy in the consumption of food very great. He preferred a mixture of chaff and a little corn to corn alone, believing it as necessary for the digestion of sheep as for that of a cow that the stomach of the animal should be filled, though not entirely with highly nutritious food, to promote the mechanical process of digestion. Rich food, given in excess of the animal's requirements, is but a waste of money; since a bulky material of less value would more effectually promote digestion. At the time of weaning, his lambs were so managed that they hardly knew when they were weaned. The ewes and lambs were at that season fed on clover, or on artificial grasses in two pens partly separated by gates, through which the lambs could pass. The lambs running through the gate had the first cropping of that which the ewes would have to eat up, and were here supplied with the dust of cake, or something else which they took to kindly. When weaned they had no objection to leave off their mothers, and resort to the food to which they had thus by degrees become accustomed.

He should like to know a little more with regard to the use of nets, by way of saving hurdles. This practice was more or less applicable according to the breed of sheep kept. But with his own breed nets were continually giving him trouble; for the animals were caught in them and sometimes injured; his being in a game country, the nets were so bitten by hares that the sheep could get their heads in, and were consequently more liable to accident. On the whole, therefore, he was inclined to prefer hurdles.

Sir W. MILES, M.P., had very great pleasure in joining in the expression of thanks to the Professor for his admirable lecture, which gave them not only the theory but the practice that was followed at Cirencester; it was a history both of breeding and feeding, and

conducted the lamb through every stage, from the period of its birth till it became a full-grown teg.

Mr. DENT, M.P., observed that, as the Professor's observations had treated almost exclusively of sheep in the southern and south-western counties, he would take the liberty of making a few remarks with regard to the system of rearing them in Yorkshire. In the north, they did not get their lambs dropped until the latter part of March or the beginning of April; therefore the weaning time this year was yet to come, and it was usually in July and August. Upon nearly all farms where there was old grass-land it was a rare, and, according to his experience, not a good thing, to run the ewes in lamb upon turnip-land. In fact, the winter before last, his ewes had no turnips until after lambing, against the wishes of his shepherd; yet, when lambing time came, he was compelled to acknowledge that he had never known a healthier season. There was great difficulty in managing a flock of ewes upon strong land. One or two years he had suffered severely from scour in lambs, when he had been tempted to put them back in the clover-field. During the two last seasons he had found the best plan was to place them upon old grass-land, which had not been stocked with sheep through the previous part of the year. From thence he put them upon white mustard, either sown by itself or mixed with rape, a remarkably healthy crop for young lambs, which would eat the young mustard upon its coming into flower before they would touch the rape. He thought the system of folding mentioned by the Professor must be a good one; but it was not carried out that he was aware of anywhere in the north. Some time ago he read with much satisfaction a paper by Mr. Bond, of Suffolk, upon the management of breeding-flocks of ewes upon strong land.

The practice of folding in summer was not known in Yorkshire. There, too, a hurdle was scarcely ever seen, and they suffered much from game. When nets were used, they were bitten in holes by the hares, and took a good deal of mending. The sheep were, therefore, left to run over the seed-field. He recollected some endeavour being made to fold ewes and lambs in meshes: but that year two lambs got hung in the nets, and he had known a case or two of tegs or full-grown sheep hanging themselves in the same manner: that, however, was not frequently the result.

It was important to know what could be substituted for clover in the case of a flock of breeding ewes. In the north, great difficulty was experienced in growing clover once in four or even five or six years, and he should be glad to see his way to the adoption of some rotation. The idea of vetches and rape together for feeding off seemed to be a very good one. In the East Riding it was a common practice to take a portion of land that ought to be in clover and sow it with vetches, to be eaten off early, and followed by rape. As to ewes producing pairs of lambs, he might mention an interesting fact. Last year he wanted some additional sheep, and purchased 45 Leicester ewes of capital quality and in excellent condition. After he had them he put them with his other ewes upon rape and white turnips, with the same rams; but out of the whole 45 nearly 30 were barren,

and he attributed this to the fact that he did not keep them so well as they had been kept by their former owner, and that consequently they had fallen off in condition when put to the ram. In this opinion he was confirmed by the fact that the great proportion of the remaining 80 or 90 ewes bore double and treble lambs from the same rams. That appeared to corroborate the view of Professor Coleman, that the ewes should be in an improving condition when put to the rams.

Mr. P. FREE believed that malt chives given to the ewe flock would induce them to eat much more straw in mild seasons than they would otherwise be inclined to take. His practice was, to give his lambs some artificial food from the first moment when they could be coaxed to eat it. When the rapid growth of the lamb compared with that of other animals, and the speed with which it obtained the stature of its parent, were observed, it would be seen that it was particularly adapted to be fed well from the outset. It was his practice to pen his ewes and lambs in the manner described by Mr. Holland. When the weaning time was come, he substituted common hurdles for the lamb-gates. Thus the lamb and its dam were parted, but not far removed or distressed, and greeted one another night and morning for a while through the fence. The only objection he had heard made to such lamb-gates was, that by curving a big lamb's back they spoil its symmetry.

Lord BERNERS had himself tried cocconut matting, but found it eaten through by the sheep in innumerable holes in the morning.

Mr. FISHER HOBBS said that the system which Professor Coleman had propounded that day so much coincided with his own practice in the management of a Southdown flock, that he would trouble the meeting with a very few remarks. This system would be found very profitable upon the light lands in an open country, since it enabled the farmer to produce mutton and lamb of early maturity. The flock might be managed under it in a manner very superior to the system adopted in the northern and midland counties. Indeed, a flockmaster might keep from two to four sheep per acre, besides a certain number of beasts, if his grass-land were good, and thereby make a better return than in any other way. He should like to know, however, in what way the washpool was to be used? Of course, it could only be at a period of the year when the ewes were not in a state of gestation, and could only be required during the summer months.

Swedes had been recommended after lambing time. Some years since a friend of his, Mr. Edwards, of Sutton, Suffolk, who kept a large flock of sheep, having lost 100 lambs before they came to maturity, wrote to him for his advice in the matter. The first question he then put to Mr. Edwards was, "Did you feed your ewes on swedes before lambing time?" and this proved to be the case. The use of rape for lambs in the summer months was very important. Within the last fortnight he had lost 10 or 12 acres of coleseed entirely through the drought. The field had grown winter oats and vetches, and sheep and lambs had been feeding upon it with abundance of oilcake; it was well ploughed, but when the seed came up the recent excessive drought destroyed the whole piece. In his neighbourhood, especially on such

land as he occupied, they depended much during July and August upon the early dwarf-rape,—a variety which, he believed, was not commonly used. He had had his from Dorsetshire, and it had turned out to be of very great value. He sowed it 18 inches apart, and harrowed it frequently, and in eight or ten weeks it made the best and most fattening food for sheep that he had ever met with at that particular time of the year. It was unfortunate that in the course of the last three years, as Mr. Coleman had shown, the supply of sheep in this country had greatly diminished, whilst the population had gone on increasing. This pointed out the special necessity for increasing the breed of sheep.

Mr. HOLLAND drew attention to the great mortality amongst the sheep in Lincolnshire, owing to the attempts which had been made to cure the scab in particular by means of mercurial preparations, which were generally used as an ointment. This ointment had the effect of shutting up all the pores of the skin, but not until the mercurial properties had had an injurious influence upon the health of the animal. Scores of sheep had died from this cause; and after death it had been discovered that where the mercury had entered into the system the meat was bad for human food. It stood to reason that, if the pores of the skin were stopped over the whole surface of the animal, those particles which ought to escape from the body—such as carbonic acid gas—would be driven into the system and become mixed with blood, and so the whole system be deranged. Now, this ought to be guarded against by farmers; and he was glad to hear from the Professor that the proper dressing ought to be given in a liquid form, and not as an ointment. Analogous to the filling up the pores of the skin of the grown-up animal with ointment was, that practice of covering the lamb which had lost its dam with the skin of another lamb, which caused many deaths every year. In the same way this practice stopped up the pores of the skin, and at best produced a diseased and unhealthy animal.

Professor COLEMAN stated, in reply, that nets were not used on the College farm, because the land there was so exceedingly shallow—the soil being only 3 or 4 inches in depth—that they could not keep up the nets with stakes. Nets, however, where they could be used, offered the great advantage of easy removal. Of course, the existence of game in large quantities would constitute a fatal objection to their use; but that, he believed, was an exception rather than the rule. The size of the mesh might be easily altered, so that the sheep could not get their heads through the opening. The sheep on the College farm were principally Cotswold, and they answered exceedingly well. There was some trouble at first, and care and patience were necessary; for the labourers—and farmers, too, for that matter—were sometimes so prejudiced against any alteration, that they would not give a new food or a new system a fair trial. With regard to the washpool, he did not think its use need be restricted in all cases to the summer; on the contrary, he was of opinion that ewes, up to the period when they were half-gone in lamb, might be washed in winter.

Meeting of Weekly Council, Wednesday, June 24th. The Earl of Powis in the Chair.

THE COMPARATIVE EFFECTS OF DIFFERENT MANURES ON GRASS LANDS.

Professor VOELCKER (having placed on the table specimens of grasses collected by himself on the previous day on Messrs. Lawes and Gilbert's experimental plots at Rothamsted, to which he frequently alluded in the course of his lecture), said: My Lord and Gentlemen: That grass land is capable of improvement as much as arable land, I think few people will deny; that there is pasture land which is more difficult to improve than other pasture land, I believe most people will admit; and that, taking a wide view of the pastures of England, there is much grass land in very bad condition, which is capable of extensive improvement, I likewise think very few persons will question. The question then arises, How is grass land to be improved?—by what means, whether mechanical or chemical, can we increase our herbage, both as regards quality and quantity?

Before proceeding further, it may, perhaps, be well to look briefly at the question, What is to be considered bad and what good pasture? To which it will be no sufficient answer to say that good pasture is land which gives us good herbage and an abundant crop of hay. Pasture, then, or grass land in general, may be bad for three reasons. First, the soil may be good enough, but unfortunately there may be too little of it. Secondly, the physical texture of the land may be bad; there may be plenty of materials, but the grass may rest on a stiff, impervious clay soil 3 feet deep, or on a sub-soil which cannot be readily drained, in which cases the herbage will never be very abundant, and will often come imperfectly to maturity. Thirdly, the soil may be bad, because something or other is defective in the land,—some ingredient wanting which is necessary to the luxuriant growth and full development of the plants. It is evident that, according to the nature of the defect in the soil, we must order our plans of improvement. If pasture is bad or indifferent on account of any mechanical or physical deficiency, it is vain to apply to it manuring constituents, which, however useful they may be on land which is porous and well drained, though naturally poor, produce little or no effect on undrained cold clays. On pasture land, however, which has been drained and otherwise deprived of its superabundant moisture, manuring is, no doubt, one of the most important means of improvement.

The proper selection of fertilizers for grass land cannot be well understood, if we disregard the special effect which certain manuring constituents, such as nitrogen, or mineral matters—phosphatic manures, alkalis, or lime, produce on the quality as well as the quantity of the herbage. I do not know of any series of experiments calculated to bring more forcibly before an observer's view the remarkable effects which such manures produce on certain grasses than the very carefully conducted experiments at Rothamsted. These experiments have been carried on now for a series of years with an amount

of skill, care, and deliberation, involving great expense, which renders them extremely valuable. I speak strongly on this subject, because I think the merits of the researches of Messrs. Lawes and Gilbert have scarcely met with the amount of recognition from the great body of agriculturists and from scientific men to which they are entitled. The longer I live, the more deeply am I convinced of the necessity of carrying out in our fields experimental researches, similar to those which have been conducted for so many years at Rothamsted. The grass experiments which have been carried on in the home park are especially valuable; and I only wish I could take my audience down to the field, and give them a field lecture there, instead of having to direct their attention to diagrams and to a few specimens which I was so fortunate as to secure yesterday evening, and have brought with me this morning. I hope, however, to be enabled to show the meeting how a certain description of manure fosters certain species of plants, and how it likewise increases the total quantity of produce.

The most valuable manuring substances are the following:—First, nitrogen, either in the shape of ammoniacal salts, or in that of nitrates, and organic matters capable of producing on decomposition either nitrates or ammonia: secondly, the phosphates; and, thirdly, the alkalis. These are the most important; but we have also to consider the effects of lime and silica. What, then, are the effects of ammonia upon grass land? These, in the first place, vary according to the presence or absence of available minerals,—that is to say, with the quality of the soil. If there is an abundance of valuable mineral matter, and if this be present in an available condition—that is to say, in such a state of combination that it can be taken up by the roots of the plants—then ammoniacal manures are very valuable indeed, for they promote a very luxuriant development of the herbage. But if the mineral constituents—the phosphates, the salts of lime, the alkalis, and the soluble silica—are deficient, by the application of ammoniacal manures alone we should deteriorate the quality of the herbage, and within a very few seasons there would be no very large impression visible in its quantity. The diagram before you states that the produce of the unmanured portion of the land at Rothamsted has amounted to about 1 ton 6 cwts. The ammoniacal salts alone have not increased the produce nearly so much as when given in conjunction with minerals. The produce in the latter case is nearly treble that in the former. The addition of ammonia even to farmyard manure produces a striking effect. The latter contains but little ammonia in comparison with the amount of mineral matter and carbonaceous matter there present. To dispose at once of the carbonaceous substances—organic matters free from nitrogen, and containing chiefly carbon and hydrogen with some oxygen,—I would say that in Mr. Lawes's experiments I have found scarcely any effect from them either on the quality or the quantity of the produce. In farmyard-manure it is not so much the carbonaceous element which tends to increase produce as the nitrogenous and mineral portion.

But the specimens which I have brought here this morning are better calculated than these remarks to give you an idea of the

special effects of ammoniacal salts. Here [pointing to specimens] we have the produce of unmanured land, and here again we have some of the herbage of the land to which ammoniacal salts have been applied. You will notice in the latter a difference in the colour: the grass is a deeper green; it is also somewhat higher, and there is more of it. There is also this remarkable difference, that whereas in the unmanured portion we have great variety, a large mixture of plants, through the application of ammoniacal salts the herbage becomes more simple. When ammoniacal salts have been applied in conjunction with mixed minerals, the effect is very striking; indeed the quantity of produce is double that derived from ammonia alone. An extra quantity of ammonia increases the produce to a very remarkable extent, and it further reduces the number of species of plants, pushing forward certain grasses to the exclusion of almost every other. Among the first to disappear are the leguminous plants, especially if large quantities of ammonia are applied, even though a supply of mineral matter may be present, and these are among the more nutritive of our herbs. On the whole acre plot thus treated, which I saw yesterday, it would, I think, be difficult to find any clover; and moreover, it is almost amusing to observe how certain grasses take the place of others. Thus, when a large dose of ammoniacal matter is used in conjunction with minerals, cocksfoot especially and tufted hair-grass supersede many other grasses. The specimens placed in bunches on the table were selected to give a general idea of the constitution of the herbage and the height which it attains on the several plots.

The effects produced by nitrates seem in some degree to differ from those of ammonia. Nitrate of soda does not so materially affect the leguminous tribe of plants as do ammoniacal salts. As to mineral matters, phosphatic and alkaline substances may be fairly taken together; for those plants which are stimulated by phosphates are also benefited by alkaline manures, and more especially salts of potash. The action of mixed mineral manures, composed of phosphate of lime in a soluble condition and salts of potash, on the whole clover tribe of plants is very remarkable. Under its influence you can see clover not merely here and there, but all over the plot; while the rougher grasses are less luxuriant. The cocksfoot here appears to be almost a different plant from that which received an excess of ammonia; it is much lower, and not so luxuriant; while the red and white clover and the wild vetch are seen all over the field. In other words, alkalis and phosphates promote a good quality of herbage; but they have not as great an effect upon the amount of produce.

Returning now to the subject of the improvement of pastures, let us suppose that the land has been well drained, that it is moderately porous, and that there is a fair depth of soil; but that the produce is scanty, and the herbage not very good. How are these defects to be remedied? can both be dealt with at once? In most cases we ought, I think, to endeavour to improve to some extent at least the quality of our herbage, and at the same time try to get not an excessive but a remunerative amount of produce. If we look too much to quality,

perhaps the means of effecting improvement may be considered by practical men too expensive; on the other hand, if we look entirely to quantity, the quality of the herbage may be much deteriorated: and the result will be remunerative only to the men who sell hay in the neighbourhood of large towns, but not to the consuming tenant or to the landlord.

But, first of all, we ought to ascertain whether a pasture requires liming or not. As this is frequently the case, and as lime or marl is a cheap manure, before we go to any great expense we ought to settle this point. Lime, which has done marvels on some description of grass land, on others has produced little or no effect. The geological formation of the rocks of a district is not always a good guide in deciding the question whether land requires liming or not. I have met with many cases in which lime has done an immense amount of good, although the land was situated on the oolite formation, abounding in limestone rock. In such regions fields are often to be found in permanent pasture composed of clays of transportation, which have not arisen from the rocks on which they are placed. Such soils, though deposited on limestone rocks, may have been formed from other rocks deficient in lime. Such may be the case even though the limestone may crop out upon the surface; and anyone who was not acquainted with the special character of the land might say that no lime could be wanted, seeing that it came up to the surface; yet the actual soil may, notwithstanding these appearances, be very materially benefited by liming.

Fortunately, this is a question which may be readily settled. Let a little of the soil be put in a small cup or saucer, and be mixed with spirits of salt (muriatic acid). If it effervesces strongly, an abundance of lime is present; and in that case the land requires no liming. The absence of effervescence, however, is not always an indication that the land is deficient in lime. Soil may be in a condition in which it is not easily attacked by common spirits of salt. In that case no effervescence would take place, and yet sufficient lime may be present; but simple analysis will then very readily clear up the doubt. If land be of a light description, clay marl may be the best dressing; for then we not only apply lime, but we also add to the land a material which generally is rich in potash and soda. Marl, moreover, is valuable as an absorber of fertilisers, whether derived from the atmosphere or from the manure applied to the land. To encourage the growth of good herbage, as well as increase the quantity of the produce, a liberal manuring should be given. Land which is so porous that an excess of water will not remain on it in wet seasons for any great length of time, and which in dry weather can by capillary attraction bring up moisture from below, pays exceedingly well for a judicious outlay on manure. Indeed, all grass land should receive an occasional application of farmyard-manure; for this alone can supply alkalies, more especially potash, in an economical manner. If we look at the composition of the ashes of our grasses and our hay, taking the mixed grasses and leguminous plants together, we shall find that those ashes abound in potash. If we constantly mow down our grasses, we

thereby remove a very large proportion of the alkalis; and the result is that the herbage becomes poor, and the produce falls off. It is difficult to conceive why the farmer is so anxious to apply nearly all his farmyard-manure to his arable land, and deals it out in such a niggardly manner to his pasture.

But, in addition to farmyard-manure, there are other fertilizers which may be used with very great effect. Guano, judiciously used—that is to say, used on land like many of the clay soils, which constitute, perhaps, most of our pasture soils—produces a very excellent effect upon the produce. Better, perhaps, than guano alone, or bones alone, is a mixture of the two. Indeed, I should like for an average description of land the following mixture: partially-dissolved bones, or bone-dust, dissolved with a sufficient quantity of sulphuric acid to render a portion of the phosphates soluble. We obtain partially-dissolved bones by applying to bone-dust one-third of its weight of sulphuric acid; 4 cwt. of partially-dissolved bones, 2 cwt. of Peruvian guano, and 1 cwt. of salt, perhaps, will produce a manure for pasture which, whilst it will materially increase the produce, will not to any great extent deteriorate the quality of the grass, as might be the case if we used guano alone in the rate of 4 cwt. per acre. This mixture contains the chief mineral constituents required by our grasses and leguminous crops, and adds a fair amount of ammoniacal matter to give us a good yield. The addition of salt is of use, particularly on light land, by keeping it in a moist condition.

An excess of salt ought, however, to be carefully avoided. I remember that some years ago Mr. Sotheron-Estcourt tried some experiments on his own farm with nitrate of soda and salt. He used on one plot a mixture of $1\frac{1}{2}$ cwt. of nitrate of soda and $10\frac{1}{2}$ cwt. of salt, that by the addition of the salt he might make the money value of the mixture equal to that allowed on his other similar experiments. Here the addition of salt to the nitrate of soda destroyed the peculiar effect of the nitrate almost entirely, and the increase of produce was very small indeed. The same mixture when tried on another farm of Mr. Estcourt's, on very wet land, had the same effect: it actually reduced the herbage. Salt in excessive quantity checks vegetation; and hence, on wet land, it ought to be used with great judgment.

The effects produced by the application of bone-dust to pastures are very variable. On the porous land of Cheshire, and similar soils on the red sandstone formation, the result is very striking. Not only do bones there bring out white and red clover, but promote an abundance of the growth of succulent grasses. The clover itself becomes very luxuriant and thus helps to increase the produce. On land which is wet and cold, and rests on a poor undrained subsoil, bones often produce no effect. A great many pastures in the West of England, in Somerset, and Devon, a considerable portion of the grass land in Gloucestershire, and, I may add, some of the heavy land which I have seen in Shropshire, cannot be improved by bones. Before, therefore, much money is spent on bone manure, I would recommend that a trial should be made on a small scale.

Let me add, that care should be taken by purchasers of bone-dust to obtain a genuine article; for bone-dust, particularly of the finer kind, is frequently mixed with cheap materials. Bone-filings, the refuse of button-manufacturers and bone-turners, has of late years become very much deteriorated in quality by the admixture of vegetable ivory, now very largely used, as well as bone, for the turning of buttons; the combination is so complete that it is very difficult to distinguish the bone-filings from the vegetable ivory dust, a substance which has no more manuring value than common sawdust, being of the same nature. Boiled bones, the refuse of the glue-manufacturers, when obtained in a dry condition, are extremely valuable. They have then been deprived of all their fat, and of about half their nitrogenous matter. It is surprising that they should still contain one-half the quantity of nitrogen which is to be found in fresh bones. Therefore glue-makers' refuse, when dry, is very useful in improving the pastures of dairy districts like those of Cheshire.

The next question which we have briefly to consider, is, What are we to do with cold wet land, on which farmyard manure and artificial manures make no great impression? Doubtless it is not easy to improve such pastures. Some of the dairy farmers, when blamed for not improving their pastures, will tell you that they have tried farmyard manure very largely, and also various artificial manures, but have not succeeded in getting a return for their outlay of money. It would seem that on grass-land of this description, which rests on a subsoil, wet, undrained, and difficult to drain, the manure passes away, somehow or other, without producing much effect. In such instances, until the question of drainage has been solved, the application of manures would but lead to waste; that, however, is a point for the consideration of the engineer. Let us now suppose the worst case—that experience has pointed out to us that the land is not grateful for draining, and therefore cannot be much improved by the addition of manure, and also that it cannot be broken up. The question of the desirableness or otherwise of breaking up such land is one far too wide to be discussed here; and therefore I will not touch upon it; there may be good reasons for either alternative. In this, the worst of all cases, I would recommend, from my own experience, the addition to the surface of bulky manures. I would scrape together whatever I could of what is commonly considered valueless material; I would collect the sweepings of the yard; I would scrape the roads well, and collect the scrapings: I would employ a man to collect the droppings of the grazing stock by means of a donkey-cart, and I would keep him constantly at work in raking up the droppings, mixing them with the road-scrappings, and adding a little lime to this material, if the land is deficient in lime. It is astonishing what a quantity of manure may be collected in this way; and by applying such an earth-compost just at the growing season of the year, when the grasses are making a start, we can often improve them very materially, if we have the compost ready. Such compost for grass land ought to be kept for at least six months, and be turned over once or twice before it is put on

the land; when this is done, the air finds free access through the organic refuse matter, and converts the nitrogenous portion of it into nitric acid, which is fixed by the earthy matter. We thus obtain in a compost-heap which has been kept some six or eight months a considerable portion of nitre; and this has an excellent effect on the herbage, particularly on plants of the cereal tribe. By such means we may make the best of the worst description of pasture.

Very briefly recapitulating the main points which I have endeavoured to bring out in this lecture, I would remind my audience, first, that ammoniacal manures have a special effect in producing a luxuriant development of the cereal tribe of plants; and that if the necessary amount of mineral matter is present, they largely increase the general produce. We have seen, further, that mixed mineral manures composed of phosphoric and alkaline salts increase the leguminous produce; that the sole application of ammoniacal salts ought to be avoided; and that it is best to have a fair mixture of both mineral and ammoniacal matters. Again, we have seen that there are soils which are very grateful for a liberal expenditure of money, this being the condition of a great deal of the grass land of England at the present time. Though an indolent farmer may find an excuse in the fact that there are here and there soils which cannot be improved, nevertheless pastures may be improved by a judicious outlay on manuring substances to an extent, and with a profit, of which few people have any idea. Lastly, we have seen that on the poorest description of grass land, waste matters, the droppings of cattle, earthy substances, and such like, may be conveniently made into a compost manure, which on such soils will produce a very excellent effect.

Sir GEORGE JENKINSON asked whether the different samples exhibited were each pulled up in one handful from one particular spot in the trial field, or whether the bundles were made up of selected grasses culled from various parts of the field.

Professor VOELCKER replied that the specimens represented as nearly as possible the general character of the experimental plots.

Mr. THOMPSON said, having had an opportunity of seeing the experimental plots on the previous day, he could corroborate that statement. The plots consisted of an acre each, and if there was one thing more striking than another, it was the uniform character of the herbage over each of the plots. There might be some differences arising from the movements of the sheep by which the after-crop is always eaten off, but the exceptions owing to that cause were confined to a very small proportion of the plots. On the whole, the herbage of the several plots presented a very distinct outline. When revisiting these plots (which he had frequently examined before), after an interval of two years he had been particularly struck with the development of the particular characters of herbage on the different plots which had been treated in a particular manner, for a succession of years. It showed how much they had at their command the growth of the herbage on land which, at all events, was not what they would naturally call good grass land.

The crop on other parts of the farm showed that such was the natural character of the land at Rothamsted. The soil was a strong clay, much better suited for the growth of wheat and beans than for the production of grass; yet it was clear that they could grow on such land almost any herbage they pleased. The question was rather one of money, and of the particular kind of herbage required, than anything else. Considering the kindness of Mr. Lawes in showing the plots to any one who visited him, it was strange that a much greater number of persons did not go to Rothamsted. The land there afforded the most extraordinary illustration of the effects of manuring that any one can conceive. Besides the experiments with the grasses, there were similar ones with wheat and barley, all carried on with such care and accuracy that they might be thoroughly depended upon. They had, in fact, been continued so long that each plot had now developed its own peculiar character. He ventured to say that in a single morning, farmers, by walking up and down these plots, and making proper inquiries, might obtain more knowledge of experimental farming, and of what might be done for the improvement of various kinds of land, than they would acquire in a lifetime on their own farm or that of a neighbour.

Sir GEORGE JENKINSON inquired under what head Professor Voelcker would class liquid manure which flowed from a cesspool-tank. He had lately conducted the sewage of his house by pipes on to his pasture, and found that wherever it was allowed to run, there was a marked line of thick, rank, dark-green grass; it was, in fact, twice or three times as thick as the grass in other parts.

Professor VOELCKER said the liquid manure alluded to must be chiefly ammoniacal manure; but, inasmuch as it contained also mineral matters, it was a mixed ammoniacal and mineral manure, and that admixture was, no doubt, the cause of the abundant development of herbage which had taken place.

Mr. DENT, M.P., wished to ask the Professor one or two practical questions. First, as regarded soils which required liming—In what condition is it best to apply lime to the grass? What time of the year is best for the application of lime, and also of artificial manures to grass land? When the Professor and those who make scientific experiments use the expressions mixed manures and ammoniacal manures, of course they know what is meant by such terms; but many farmers would like to be informed what they should apply as a mixed mineral manure. The dressing proposed by the Professor seems to be a rather more expensive one than many tenant-farmers would like to apply. Four cwts. of dissolved bones would probably cost 7s. per cwt., making 28s.; 2 cwts. of guano would cost 26s.; and 1 cwt. of salt, 1s. That would give a total of 55s. per acre; but tenant farmers generally would not be disposed to expend more than 2l. per acre in manuring their grass lands. He would therefore venture to suggest as a suitable dressing 3 cwts. of superphosphate, $\frac{1}{2}$ cwt. of sulphate of ammonia, and $\frac{1}{2}$ cwt. of guano, which together would come to about 35s. per acre.

Mr. LEE: Did the Professor intend to recommend the application

of so large a quantity as 7 cwts. of artificial manure per acre for grass land?

Professor VOELCKER: I have no doubt that on some land that quantity might be used with advantage.

Mr. LEE suggested that 2 or 3 cwts. of artificial manure would be enough, and inquired whether Professor Voelcker's recommendation, and Mr. Lawes's experiments went up to 7 cwts.

Sir JOHN JOHNSTONE, M.P., said, Mr. Lawes's experiments went up to 8 cwts. per acre; but where that dressing had been applied, the coarser feeders amongst the plants, especially the enormous cocksfoot, grew so strongly that Mr. Lawes expected that within two or three years it would drive out almost every other grass; in fact, that the plot would become a bed of cocksfoot. That showed what was the effect of an excess of ammoniacal manure. The cocksfoot was getting ahead of everything; it was even driving out another common grass, the *Holcus lanatus*, which was a very coarse feeder.

Professor VOELCKER said that autumn was the proper time for the application of lime to the land. As regarded the mode of applying it, he liked that of Devonshire best. In that county it was put on the land in small heaps, and covered over with earth, it thus got spontaneously slaked: early in the spring it was spread in lumps over the land, and the lime washed in by degrees. Soil could be obtained from the ditches of the road-sides, which would do: it was not necessary to make a regular compost heap where earth was available. Lime so slaked falls into a fine powder, and could be more easily distributed on the land. Farmyard manure might be well laid on about Christmas; for artificials—the end of January or the beginning of February would be a good period. As regarded the quantity of artificials which might be used with advantage, he purposely gave a liberal application. Knowing that most tenant-farmers were not inclined to make such outlays, with the view of pushing them a little further than they were likely to go, he recommended a larger dose than perhaps he might use himself (laughter). But they had only to divide by two to get very good manure. 2 cwts. of dissolved bones and 1 cwt. of guano, constitute a very good dressing; and if the dose should still be found too expensive, it might be divided by three. He had been more anxious to point out the relative properties of dissolved bones, guano, and salt, than to fix upon any particular quantity of manure for grass-land. There was another manure, namely soot, which when obtained in the neighbourhood of large towns at a moderate price, 6d. to 8d. per bushel, produced very good results on pastures.

Mr. FREERE.—What do you call a moderate price?

Professor VOELCKER.—Sixpence a bushel, if it is pure.

Lord WALSHINGHAM.—But soot was always adulterated, and could rarely be had pure.

Professor VOELCKER.—Even at 8d. a bushel soot was a cheap manure; and it owed its efficacy chiefly to the sulphate of ammonia which had produced such a marked effect upon the grass lands on which Mr. Lawes carried on his experiments.

Professor BUCKMANN said, In going over Messrs. Lawes and

Gilbert's plots on the previous day, he was much struck with the manner in which the experiments were being carried out, and also with the scale on which they were conducted. The meadow was divided into two parts; one part being left in its natural state, and the other staked off with a view to the experiments. Among the natural grasses he saw almost every species of grass which was usually met with, and that too on land not of extraordinary quality. This was a very striking fact. If a man went from one end of England to the other, say from Mr. Lawes's farm to the Land's End in Cornwall, he would find that almost every ordinary meadow contained the same species of grasses. Occasionally one met with grasses of a peculiar character, but real grasses were nearly always alike. There was this important fact to be observed with regard to the proportion of the different species. In one part of England they would find that one kind of grass had almost taken possession of the land, other kinds being barely represented. That fact was interesting in connection with these experiments; if he took two species of grass, one being, say, the *Festuca pratensis*, a very rich grass indeed, and if he examined a plot and found that grass prevailing, and compared it with land which was not manured, he would see on the unmanured land that grass largely represented. So, again, with regard to the *Festuca duriuscula*; in the part which had been so highly manured and which had the mixture of phosphate with alkalies, he found that the *Festuca duriuscula* was not present in such large quantities as the *Festuca pratensis*. Where the *Festuca pratensis* prevailed, there was a distinct kind of manuring from that which was adopted where the *Festuca duriuscula* prevailed. Had he been at all aware that he should be called upon to speak, he might have entered into the subject more fully. He must say that he entirely agreed with Professor Voelcker as to the advantage of visiting the plots, and that what he saw on the previous day convinced him of the very great advantage of field lectures on agricultural subjects in comparison with lectures in a room. One thing which struck him in examining the plots was, that in the case of impoverished pastures there was a great variety of species mixed together, not yielding any very large quantity, and probably the quality not being very good; whereas, as soon as the land has been dressed with certain manures a sort of war of extermination commenced. Not that the poorer grasses could ever be entirely eradicated; but when good grasses had begun to spring up in any quantity the poorer species declined. How far chemistry would account for it he did not know, but it would be easy to make a list of grasses and give to each its positive status with regard to nutritive power, and from what he saw the previous day he came to the conclusion that the use of good mixed manures almost completely drives out some species of grass and encourages the growth of others to a very extraordinary extent. It was an important fact that on these experimental plots the grasses had actually been mown every year. In mowing grasses every year it would be found that almost all the good and more important species would be, if not driven out altogether, brought into a state of pauperism; they became so small

and poor that it would require the piercing eye of an experienced botanist to distinguish them; but let the land have been manured with different manures, and it would be found that, according to the manure employed, whether it was a manure that would produce muscle, or a manure that would produce mineral, or whatever might be its nature, they would have the grasses which would produce those different ingredients to the fullest possible extent. This had struck him in the case of an estate, with respect to which he had recently been consulted, called Buscot Park, where there were several thousand acres which were either being converted from arable into grass lands; or, being grass lands, were being, as far as possible, improved. On that estate some of the grasses were excessively poor. The question came before him, whether there would in that case be any advantage in taking off the turf, digging the land underneath, and returning the turf again. Another question which he had to consider, and it was an important practical point, was whether, when the turf was had, showing a preponderance of poor material, it would be the quickest method of making good grasses to plough up the land altogether, and resow it with grasses. To these questions he was obliged to give this answer: that digging the soil and returning the turf would perhaps cause some little appearance of freshness for the first year, but that it would do a great deal of injury to the turf. For with all the appliances of manure, there was one thing which ought to be particularly attended to in relation to the improvement of grasses, and that was mechanical action. Without sufficient mechanical pressure, grass would grow up very much in the form of jungle. There should, therefore, be an endeavour to make the different parts of the soil adhere as closely as wool in making a piece of cloth. Then, with regard to the operation of merely digging the land, he could only reassert what he thought had been clearly proved by Dr. Voelcker, that that would add nothing to the staple of the soil. Something was of course wanted where the grasses were poor, but the process of ploughing would add nothing to the quality of the soil, while on the other hand the compact nature of the turf would be destroyed. Moreover, while the land lay fallow a great deal of mechanical pressure would be necessary to get it into a state of improvement. With regard to the second point, he saw quite sufficient in the experimental plots on the previous day to throw great light upon it. The application of certain manures appeared to have turned the grasses topsy-turvy; that was to say, taking the same space for a comparison, there was 50 per cent. in parts of the field which were not manured at all; that in other parts of the same extent there was 70 or 80 per cent., with only one or two years' manuring. In that way it had been proved that inasmuch as in almost all turf, however poor it might be, some of the better grasses were represented along with the poorer, whenever they began trying to ameliorate those grasses they would see evidence that an amelioration was taking place, in the circumstance that the poorer grasses were gradually dying out, and that in dying out they not only afforded spaces for the better grasses to grow but their substance afforded a manure on which the better grasses thrived.

These experiments of Mr. Lawes's appeared therefore, to him fully to bear out the fact that in order to ameliorate poor grasses and place the richer grasses in a majority, the best and cheapest course was to apply to the land different kinds of manure.

He left it to the chemist to say what kinds of manure were required in each particular case; but he would assume it to be a positive fact that, aided by a combination of chemical with botanical knowledge, they would be enabled within a very short time to predicate from the appearance of pastures not only in what grass lands were deficient, but also what kinds of substances were required in order to remedy that deficiency. He had some floating notions in his mind that such would be the case before the preceding day, but what he then saw had completely convinced him. Perhaps the whole of the land unmanured would yield a ton per acre; but on some of manured plots, and they were placed side by side, so that there was no difficulty in judging, the produce was as much as three tons per acre. The change which had taken place as the result of the manuring, both in the quantity and the quality of the herbage, was enormous during his visit.

The question arose in his mind whether such an enormous amount of produce could be got for the hay-rick, the feeding qualities of the grass being undoubted. From what he saw of the plots which were so highly manured, he concluded that they afforded what he should call an exceedingly strong hay; hay which had, to use an expression common to farmers, a very great amount of proof in it—hay which, while it would support growing stock and assist them to grow, would add rapidly to the muscle, and so forth. He should state, however, that there appeared to be an absence in these grasses of what would be termed fattening materials. It was possible, he thought, so to manage manures as to make a great change, not only in the species and quality of grasses, but also in the quantity of the produce. So also they might be enabled to decide the question whether it were well to employ grass land always for grazing or always for making hay. Probably Professor Voelcker would some day be enabled to show that the plan which would yield the greatest amount of produce was sometimes to take hay, but not to take it so constantly as had been done in the experimental meadow. He could almost wish that for the purpose of the experiments part of the meadow had been mown, and the rest depastured occasionally, in order that they might see what change would take place through the depasturing, and what difference of quality resulted from a mixed course of hay and pasture.

Mr. WREN HOSKYNs said, That with regard to grass it should be always borne in mind that it was a crop which was perpetually growing in the same soil; that there was only one layer of earth below it; and that that had to furnish every year, either for the scythe or for the pasturing of cattle, a crop which never received any change like that which arable crops received from the use of the plough, the inversion of the soil, or the addition of fresh soil from below. Consequently, in applying manure to grass land, he had always derived the greatest benefit from mixing manure with a large

quantity of soil from road ditches, and every quarter whence it could be collected. However inferior this might be in quality, it contained an enormous amount of that mineral element which was continually going away from the soil. The quantity of waste soil which grass would grow through, if such soil were applied in the winter, was very great; hence a dressing might be given which in a few years would almost give the grass an additional bed to that in which it originally grew. If something of that kind were not done, and manure was constantly being applied in a stimulative or ammoniacal form, they were to a certain extent increasing an evil which was always in operation. He observed that Professor Voelcker supported that view in speaking of the effect of ammoniacal manures in certain cases on the character of the soil. This point was well worthy of attention.

Mr. THOMPSON, in looking at the experimental plots at Rothamsted the previous day, particularly noticed that although this was only the seventh year in which the grass experiments had been made, the plot which had been manured with ammoniacal dressings without mineral manures had clearly failed; whereas on land which had been cultivated every year with wheat, the application of ammonia without mineral manures had produced a good crop, even after twenty years. That showed what a great difference there was between the management of grass land and the management of arable land.

As Mr. Dent had inquired as to the best mode of applying lime to grass land, he might mention the practice in that respect which was followed in Yorkshire, where lime was the principal manure. The part of the country to which he especially alluded was the district of Craven. It was well known that, although on the mineral carboniferous limestone the grass grew in such quantities that they could fatten large beasts upon it, and was sufficient to keep milch cows and fatten beasts and oxen in winter, merely on account of the quality of the hay, yet hardly any manure was used there except lime. The general practice was to put on the land a large dressing of limestone, in a hot state, just as it came from the kiln, and to spread it so thickly as to make the surface appear quite white. This practice was found to answer very well, though the district was a lime one, and in many places the soil was not much above the limestone itself.

Mr. DENT.—When is the lime put on the land?

Mr. THOMPSON said it was applied at all periods; sometimes after mowing, in which case the after grass was given up on account of the application of lime. With regard to the quantity and value of the manure to be applied to grass land, Mr. Dent had objected to Professor Voelcker's estimate as being too high, or beyond the means of tenant farmers generally; and the Professor, in noticing that objection, said, the quantities which he had mentioned might be divided by two, or even three. Now he (Mr. Thompson) must protest against the last-mentioned process of division. A rather large experience in experimental manuring had convinced him that if they wanted to improve grass land it would not do to trifle with the matter, and that the outlay of money on a very small application would probably be thrown away. If they wished to improve their grass land, they had better by

far manure a small quantity of it one year well, and another small quantity the next, than spread the manure in limited quantities over the whole surface at one application; inasmuch as a very light dressing was almost sure to be lost, whilst one heavy dressing produced a change in the quality of the grass which would be visible for years.

Mr. FRERE thought that when lime was under consideration, it might be well to examine into the different qualities of lime derived from various sources.

Mr. WREN HOSKYNs wished to add one word with regard to the time for applying farmyard manure. The practice which prevailed among farmers in this country was to apply it just at the time when the young grass was shooting. Although the Professor recommended its application in the rainy month of February, yet, if the ammonia was to act on the leaf of the growing plant, that did not appear to be the best period; and he should be inclined to say that the best period for the application of farmyard manure was during the months of July and August, when the young grass was growing after the mowing; and that was, he thought, almost the universal practice.

The Chairman said, After the discussion which had taken place, nothing now remained for them to do but to thank Professor Voelcker for the lecture which he had been good enough to give them that day.

SELECT CLASSIFIED LIST OF AGRICULTURAL PATENTS FOR THE YEAR 1862.

[Compiled from the Commissioners of Patents' Journal.]

In this list such patents as originated in the year 1861, and were noticed in Vol. XXIII. of this Journal, are distinguished by having an asterisk (*) prefixed. The figures at the commencement of each item indicate the number of the patent on the official register.

The patents under each head are arranged alphabetically according to the name of the Inventor.

I. IMPLEMENTS USED IN THE VARIOUS PROCESSES OF CULTIVATION.

PLOUGHS.

- 71. John Carter, of Tipton, Staffordshire, *An invention of a new or improved draining Plough.* Application dated 10th January; provisional protection, 31st January; notice, 29th April; patent sealed 27th June, 1862.
- 1862. William Clark, of 53, Chancery Lane, patent agent, *Improvements in Ploughs.* Application dated 25th June; provisional protection, 4th July; notice, 21st October; patent sealed 16th December, 1862.
- 3325. William Goulding, of Leicester, *Improvements in Ploughs.* Application dated 11th December; provisional protection, 26th December, 1862.
- 108. Thomas Harrison, of Birmingham, Yorkshire, foreman on the Glebe Farm, and J. G. Harrison, Kirby Ravensworth, blacksmith, *Improvements in Ploughs.* Application dated 14th January; provisional protection, 14th February; notice, 27th May; patent sealed 11th July, 1862.
- 427. J. H. Hastings and James Freezer, of Holkham, and John Woods, junr., of Wells, Norfolk, *Improvements in Ploughs.* Application dated 18th February; provisional protection, 7th March; notice, 11th March; specification published 27th September, 1862.
- 3376. Leonard Latter, of Leigh, near Tunbridge, Kent, farmer, *Improvements in Ploughs.* Application dated 17th December.
- *2155. Lemuel Dow Owen, of 481, New Oxford-street, *Improvements in Ploughs. (A communication from the United States.)* Application dated 30th August; provisional protection, 18th October, 1861; notice, 7th January, 1862.
- 1799. Joseph Warren, of Maldon, Essex, implement manufacturer, *Improvements in Ploughs.* Application dated 18th June; provisional protection, 18th July; notice, 21st October; patent sealed, 16th December, 1862.
- 3377. Robert Wheeler, of High Wycomb, Bucks, brewer, *Improvements in Ploughs.* Application dated 17th December; provisional protection, 26th December.

CULTIVATORS, DIGGERS, &c.

- 2699. Thomas Beards, of Stowe, Buckinghamshire, *Improvements in machinery for cultivating land*. Application dated 6th October; provisional protection, 17th October, 1862.
- 707. G. T. Bousfield, of Loughborough Park, Surrey, *Improvements in machinery for digging and disintegrating the earth for agricultural purposes*. (A communication from Elias Howe, jun., of New York, U. S.) Application dated 14th March; provisional protection, 4th April; notice, 15th July; patent sealed 12th September, 1862.
- 2501. R. A. Brooman, of 166, Fleet-street, patent agent, *Improvements in implements for cultivating the soil*. (A French communication). Application dated 11th September; provisional protection, 3rd October, 1862.
- *3019. John Cooper, of Ipswich, and Charles Garrood, of Penge, Surrey, *Improvements in cultivators, horse-hoes, horse-rakes, and harrows*. Application dated 30th of November, 1861; provisional protection, 17th June, 1861; patent sealed 27th May, 1862.
- 3201. James Crompton, of Bolton, Lancashire, machinist, *Improvements in machinery or apparatus for ploughing, harrowing, clearing, and drilling land*. Application dated 29th November; provisional protection, 19th December, 1862.
- 1634. William Eddington, junr., of Chelmsford, engineer, *Improvements in apparatus for draining and tilling land*. Application dated 30th May; provisional protection, 13th June; notice, 7th October; patent sealed 25th November, 1862.
- *2078. Nicholas Fisher, of Milton, near Blisworth, Northamptonshire, *Improvements in implements for grubbing and cultivating land*. Application dated 20th August; provisional protection, 13th September; notice, 22nd October, 1861; patent sealed 4th February, 1862.
- 434. William Frith, of Burley, Leeds, merchant, *Improvements in machinery for digging or turning up the soil*. Application dated 18th February; provisional protection, 28th February; notice, 24th June; patent sealed 15th August, 1862.
- 612. John Fowler, junr., D. Greig, and R. Noddings, of Leeds, *Improvements in apparatus for cultivating or tilling land*. Application dated 7th March; provisional protection, 21st March; notice, 22nd July; patent sealed 5th September, 1862.
- 1302. James W. Gill, of Woolfardisworthy, Crediton, Devonshire, *Improved apparatus for turning up and pulverising the soil*. Application dated 2nd May; provisional protection, 16th May, 1862.
- 1578. J. E. Holmes, of New York City, U. S., mechanical engineer, *Improvements in machinery for digging or cultivating land*. (A communication from G. Ramsay, of New York). Application dated 26th May; provisional protection, 13th June, 1862.
- 1577. J. E. Holmes, of New York City, U. S., mechanical engineer, *Improvements in machinery for digging or cultivating land*. Application dated 26th May; provisional protection, 20th June, 1862.
- 1744. J. E. Holmes, of South Parade, Trafalgar-square, Chelsea, engineer, *Improvements in machinery for cultivating or harrowing land*. (A communication from the United States of America). Application dated 11th June; provisional protection, 20th June, 1862.

1784. J. E. Holmes, of South Parade, Trafalgar-square, Chelsea, engineer, *Improvements in machinery for digging or cultivating land.* (*A communication from the United States of America*). Application dated 17th June; provisional protection, 27th June, 1862.
3216. John Irwin, Wellingborough, Northamptonshire, *An improved machine for cultivating land.* Application dated 1st December; provisional protection, 12th December, 1862.
- *2487. John Lansley, of Brown Candover, Hants, *Improvements in the construction of ploughs, drills, scarifiers, and such like implements; the said improvements relating to the mode of guiding or steering the same.* Application dated 5th October; provisional protection, 8th November, 1861; patent sealed 28th March, 1862.
3090. Charles Littleboy, of Straffan, county Kildare, land steward, *Improvements in implements for cultivating land.* Application dated, 17th November; provisional protection, 5th December, 1862.
875. Israel Morris, of Essington, near Wolverhampton, *An improved machine for breaking up or cultivating land.* Application dated 29th March; provisional protection, 18th April; notice, 5th August; patent sealed, 19th September.
2354. Charles Perman, of Salisbury, Wilts, *Improvements in machinery or apparatus for cultivating land.* Application dated 20th September; provisional protection, 18th October; notice, 22nd October, 1861; patent sealed 11th February, 1862.
2639. Michael Puddefoot, of Greenwich, hat manufacturer, *Improvements in apparatus for tilling land.* Application dated 29th September; provisional protection, 10th October, 1862.
565. Samuel Godfrey Reynolds, of Bristol, United States of America, *Improvements in power spading machines.* Application dated 1st March; provisional protection, 14th March; notice, 10th June; patent sealed 5th August, 1862.
201. Frederick Roberts, of Maiden Newton, Dorset, and Alexander Roberts, of Frome Vauchurch, Dorset, *Improvements in apparatus for ploughing or cultivating land.* Application dated 25th January; provisional protection, 7th February; notice, 3rd June, 1862.

APPARATUS FOR STEAM CULTIVATION.

191. John Alison, of Brightland, Reigate, Surrey, *Improvements in apparatus for tilling land by steam power.* Application dated 24th January; provisional protection, 7th February; notice, 18th February; patent sealed 4th April, 1862.
1369. G. T. Bousfield, of Loughborough Park, Brixton, *Improvements in applying steam power to tilling land by means of a digging locomotive.* (*A communication from Elias Howe, jun., of New York, U. S.*) Application dated 7th May; provisional protection, 30th May; notice, 9th September; patent sealed 31st October, 1862.
1221. William Fiskien, of Stamfordham, Northumberland, presbyterian minister, *Improvements in apparatus for cultivating land by steam power.* Application dated 25th April; provisional protection, 16th May; notice, 26th August; patent sealed 24th October, 1862.
1379. John Fowler, of Leeds, and John King, of Chadshunt, Warwickshire, farmer, *Improvements in apparatus for tilling land by steam power.*

Application dated 8th May ; provisional protection, 30th May ; notice, 3rd June ; patent sealed 29th August, 1862.

1318. John Fowler, of Leeds, *Improvements in engines for hauling agricultural implements*. Application dated 3rd May ; provisional protection, 16th May ; notice, 9th September ; patent sealed 24th October, 1862.
416. John Green, of Newtown, St. Martin, Worcestershire, *Improvements in apparatus for signalling applicable to steam ploughs or cultivators*. Application dated 15th February ; provisional protection, 28th February, 1862.
2030. John Green, of Newtown, St. Martin, Worcestershire, agriculturist, *Improvements in the method and means of producing signals, and in the application of the same, particularly to steam ploughs or cultivators*. Application dated 15th July ; provisional protection, 25th July ; notice, 26th November, 1862.
658. Collinson Hall, of Navestock, Essex, agriculturist, *Improvements in implements for breaking up the soil, and in ropes and drums to be employed in the cultivation of the soil, by steam*. Application dated 11th March ; provisional protection, 31st March ; notice, 22nd July ; patent sealed 5th September, 1862.
15. James Howard and E. T. Bousfield, of Bedford, *Improvements in apparatus applicable to steam cultivation*. Application dated 1st January ; provisional protection, 21st January ; notice, 4th February ; patent sealed 14th March, 1862.
1052. James Howard. E. T. Bousfield, and Thomas Phillips, of Bedford, *Improvements in apparatus applicable to steam cultivation*. Application dated 11th April ; provisional protection, 9th May ; notice, 5th August ; patent sealed 10th October, 1862.
2920. Jeremiah Head, of Swindon, Wilts, engineer, *Improvements in machinery employed in cultivating the land by steam power*. Application dated 29th October ; provisional protection, 7th November, 1862.
- *2169. William Hensman, of Woburn, Beds, and William Hensman, jun., of Linslade, Bucks, *Improvements in apparatus for tilling land by steam*. Application dated 31st August ; provisional protection, 18th October ; notice, 22nd October, 1861 ; patent sealed 14th February, 1862.
598. William Hensman, of Woburn, Beds, and William Hensman, jun., of Linslade, Bucks, agricultural engineers, *Improvements in apparatus for tilling land by steam power*. Application dated 5th March ; provisional protection, 21st March ; notice, 25th March ; patent sealed 13th May, 1862.
2082. Alexander Leslie, of Turriff, Aberdeenshire, farmer, *Improvements in apparatus for applying steam or other motive power to cultivate the soil and to actuate wheeled carriages*. Application dated 15th July ; provisional protection, 25th July ; notice, 18th November, 1862.
129. Robert Romaine, of Devizes, Wilts, agricultural engineer, *Improvements in apparatus to be used in cultivating land by steam power, and in steam boilers used for agricultural and traction purposes*. Application dated 17th January ; provisional protection, 7th February ; patent sealed 20th June, 1862.
3456. William Henry Samson, of Underhill, Wittersham, Kent, *Improvements in machinery for cultivating land by steam power*. Application dated 27th December, 1862.

- *1821. William Savory and Paul Haines Savory, both of Gloucester, *An improved winding apparatus particularly adapted for steam ploughing, winding at pits, quarries, and other like purposes.* Application dated 19th July; patent sealed 17th January, 1862.
 - *2264. William Stevens, of Hammersmith, *Improvements in mechanism or apparatus for ploughing and cultivating land by steam and other power.* Application dated 12th September; provisional protection, 27th September, 1861; notice, 4th February, 1862; patent sealed 11th March.
 - 2614. Frederick Tolhausen, of Paris, patent agent, *An improved steam cultivator.* (*A communication from the Marquis Emmanuel de Poucins.*) Application dated 25th September; provisional protection, 17th October, 1862.
 - *2753. A. F. Yarrow, of Arundel-square, Barnsbury, and J. B. Hilditch, of Barnsbury Villas, both in Middlesex, *Improvements in machinery used when ploughing, tilling, or cultivating land by steam-power.* Application dated 2nd November; provisional protection, 15th November, 1861; patent sealed 29th April, 1862.
-
- 384. Thomas Davison, of Belfast, engineer, *Improved means of preventing the corroding of steam boilers.* Application dated 13th February; patent sealed 5th August, 1862.
 - *2961. Alfred Vincent Newton, patent agent, Chancery-lane, *An improved method of removing and preventing the formation of calcareous and saline deposits in steam-boilers.* (*A communication by Lewis Baird, of Cambridge, Massachusetts, U. S.*) Application dated 25th November; provisional protection, 13th December, 1861; patent sealed 14th February, 1862.
 - 876. C. H. Townsend, J. Young, and J. Hankins, of Bristol, *An improved method of removing and preventing incrustation in steam-boilers.* Application dated 29th March; patent sealed 12th September, 1862.
 - 814. John Tofsham, of Manchester, mechanist, *Improvements in apparatus used for cleansing out the scum and removing the sediment from the water in steam-boilers, and preventing incrustation therein.* Application dated 24th March; provisional protection, 18th April; notice, 5th August; patent sealed 19th September, 1862.
-
- *2948. William Bray, of Deptford, engineer, *An improved locomotive apparatus particularly adapted to agricultural purposes.* Application dated 23rd November; provisional protection, 6th December, 1861; patent sealed 20th May, 1862.
 - 1705. Ephraim Death, of Leicester, engineer, *Improvements in road locomotives or traction engines.* Application dated 6th June; provisional protection, 27th June, 1862.
 - 1638. J. H. Holland, of Lorrimore Road, Surrey, *An improvement in traction engines.* Application dated 31st May; provisional protection, 13th June, 1862.
 - *2321. Joseph Lee and B. D. Taplin, of Lincoln, *Improvements in traction-engines.* Application dated 17th September; provisional protection, 27th September, 1861; patent sealed 14th March, 1862.

307. Jesse Lee, of Church Gate, Leicester, engineer, *Improvements in traction engines*. Application dated 5th February; provisional protection, 14th February, 1862.
1514. Jesse Lee, of Leicester, engineer, *Improvements in the construction of traction engines*. Application dated 19th May; provisional protection, 30th May, 1862.
3045. Abraham Pullan, of New Cross, Surrey, and William Lake, of the same place, *Improvements in traction and other engines, and in wheels for ditto and other carriages, and in giving motion to ploughs*. Application dated 4th December; provisional protection, 27th December, 1861; notice, 8th April, 1862.

HARROWS.

1731. John Alison, of Brightlands, Reigate, Surrey, *Improvements in harrows and in the apparatus for the steering or guiding of such and other agricultural implements*. Application dated 10th June; provisional protection, 27th June; notice, 8th July; patent sealed 3rd October, 1862.
945. Mark Amos, of Westbury-on-Trym, Gloucestershire, *Improvements in harrows*. Application dated 3rd April; provisional protection, 25th April, 1862.
1200. George W. Belding, of No. 7, King-street, Cheapside, London, *Improvements in harrows and cultivators*. (*A communication.*) Application dated 24th April; provisional protection, 2nd May; notice, 2nd September, 1862.
1355. J. E. Ransome, W. Copping, and L. Lanadale, all of Ipswich, *Improvements in harrows*. Application dated 6th May; provisional protection, 30th May; notice, 16th September; patent sealed 31st October, 1862.
773. Bernard Samuelson, of Banbury, agricultural engineer, *Improvements in chain harrows*. Application dated 20th March; provisional protection, 11th April; notice, 17th June; patent sealed 12th September, 1862.
1000. Benjamin Sharpe, of Hanwell Park, Middlesex, *Improvements in harrows and rakes*. Application dated 8th April; provisional protection, 18th April; notice, 12th August; patent sealed 3rd October, 1862.
2803. John Summerton, of Smethwick, Staffordshire, machinist, *Improvements in harrows for harrowing land*. Application dated 17th October; provisional protection, 19th December, 1862.

HORSE RAKES, &c.

1631. Thomas Allcock, of Ratcliffe-on-Trent, Nottinghamshire, machinist, *Improvements in the construction of horse-rakes*. Application dated 4th June; provisional protection, 27th June; notice, 14th October; patent sealed 2nd December, 1862.
1211. Peter Robert Drummond, of Perth, *An invention of a revolving rake*. Application dated 25th April; provisional protection, 30th May; notice, 9th September; patent sealed 24th October, 1862.
- *2411. Thomas Rowsell, of Buckland St. Mary, Somersetshire, carpenter, *Improvements in horse-rakes*. Application dated 27th September, 1861; patent sealed 4th March, 1862.

- *1767. Thomas Smith and George Taylor, of Ipswich, *Improvements in horse-rakes and cultivators, and in wheels for the same and other carriages.* Application dated 13th July; provisional protection, 2nd August; notice, 12th November, 1861; patent sealed 11th January, 1862.
- 2838. William J. Williams, of No. 51, Dorset-street, Salisbury-square, Middlesex, *Improvements in construction of field-rakes for agricultural purposes.* (*An American communication.*) Application dated 27th October; provisional protection, 14th November, 1862.
- 457. Charles Wood, of Bramford, Suffolk, engineer, *Improvements in horse-rakes.* Application dated 20th February; provisional protection, 14th March; notice, 24th June; patent sealed 15th August, 1862.
- 2646. Joseph Bucknall, of Boston, mechanic, *Improvements in the construction of horse-hoes.* Application dated 29th September; provisional protection, 10th October, 1862.
- *2802. Thomas Churchman Darby, of Little Waltham, Essex, farmer, *Invention of hoeing growing crops and ploughing.* Application dated 8th November; patent sealed 18th March, 1862.
- 1747. Isaac Spight, of Glandford Briggs, Lincolnshire, agricultural implement maker, *Improvements in horse-hoes.* Application dated 12th June; provisional protection, 11th July; notice, 14th October, 1862.
- 3318. Isaac Spight, of Glandford Briggs, Lincolnshire, agricultural machine maker, *Improvements in horse-hoes.* Application dated 11th December, 1862.

ROLLERS AND CLOD CRUSHERS.

- 736. William Barford (Amies and Barford), of Peterborough, agricultural implement makers, *Improvements in rollers for rolling land.* Application dated 17th March; provisional protection, 28th March; patent sealed 8th July, 1862.
- 1174. Robert Boby, of Bury St. Edmunds, agricultural implement maker, *Improvements in the construction of apparatus for rolling or crushing land.* Application dated 22nd April; provisional protection, 2nd May; notice, 26th August; patent sealed 10th October, 1862.
- 2364. J. and B. Harrison, of Otley, Yorkshire, farmers, *Improvements in clod crushers.* Application dated 26th August; provisional protection, 19th September, 1862.
- 1205. T. W. Ashby, of Stamford, agricultural implement maker, *Improved apparatus for obtaining motive power from the wind.* (*A communication from Russia.*) Application dated 24th April; provisional protection, 20th June, 1862.
- *920. John Platt, of Oldham, and William Richardson, of the same place, engineers, *Improvements in machinery or apparatus used for applying motive power derived from bullocks, horses, or other animals.* Application dated 1st April; provisional protection, 11th April; notice, 12th August; patent sealed 25th September, 1862.
- 2259. James Langran, of Kimbolton, Huntingdonshire, millwright, *Improvements in apparatus for driving agricultural machinery.* Application dated 12th August; provisional protection, 29th August, 1862.
- 925. Samuel Warren, of Ledbury, Herefordshire, agricultural engineer, *Improvements in machinery for transmitting motion obtained by animal power to agricultural and other machines.* Application dated 2nd

April; provisional protection, 18th April; notice, 5th August; patent sealed 25th September, 1862.

II. HARVESTING MACHINES, &c.

MOWING AND REAPING MACHINES.

- *1898. William Henry Ash, of London, Canada West, *Improvements in reaping and mowing machines*. Application dated 30th July; provisional protection, 9th August; notice, 13th August, 1861; patent sealed 24th January, 1862.
- 311. Adam C. Bamlett, of Middleton Tyas, near Richmond, Yorkshire, farmer, *Improvements in reaping and mowing machines*. Application dated 6th February; provisional protection, 11th April; notice, 15th April; patent sealed 29th July, 1862.
- *2957. William Burgess, of Newgate-street, City of London, *Improvements in reaping and mowing machines*. Application dated 25th November; provisional protection, 13th December, 1861; patent sealed 20th May, 1862.
- 2896. R. A. Brooman, of 166, Fleet-street, London, patent agent, *Improvements in reaping machines*. Application dated 18th November, 1861; notice, 4th March, 1862.
- 496. R. A. Brooman, of 166, Fleet-street, London, patent agent, *Improvements in reaping and mowing machines*. (*A communication*.) Application dated 24th February; provisional protection, 14th March; notice, 24th June, 1862.
- 1073. Archibald Brooman, of 166, Fleet-street, London, patent agent, *Improvements in reaping and mowing machines*. (*A communication from France*.) Application dated 14th April; provisional protection, 25th April, 1862.
- 160. William Burgess (Burgess and Key), Newgate-street, agricultural implement maker, *Improvements in reaping and mowing machines*. Application dated 21st January; provisional protection, 31st January; notice, 27th May; patent sealed 18th July, 1862.
- 2312. George Chapman, of Edinburgh, gentleman, *Improvements in reaping machines*. Application dated 16th August; provisional protection, 5th September, 1862.
- 1258. D. M. Childs, of No. 481, New Oxford-street, *Improvements in reaping and mowing machines*. (*A communication from the United States of America*.) Application dated 29th April; provisional protection, 13th June; notice, 9th September; patent sealed 24th October, 1862.
- 1136. Robert Dennison, of Lancaster, *Improvements in reaping and mowing machines*. Application dated 19th April; provisional protection, 2nd May; notice, 26th August; patent sealed 17th October, 1862.
- *2060. William Firth, of Leeds, *Improvements in machinery for digging or turning up soil, mowing, reaping, and other agricultural purposes*. Application dated 19th August; provisional protection, 30th August; notice, 24th December, 1861; patent sealed 14th February, 1862.
- *2884. Matthew Gibson, of St. Andrew's Works, Newcastle-on-Tyne, *Improvements in reaping and mowing machines*. Application dated 16th

November; provisional protection, 29th November, 1861; patent sealed 29th April, 1862.

1845. George Haseltine, of 100, Fleet-street, London, patent agents, *Improvements in machinery for mowing and reaping, the driving gear employed being applicable to machines for other purposes.* (*A communication from the United States of America.*) Application dated 23rd June; protection on complete specification, 27th June; notice, 1st July; patent sealed 5th September, 1862.
718. James Hunter and Robert Scott, of Coltness Iron-works, Cambusnethan, *Improvements in reaping machines.* Application dated 15th March; provisional protection, 11th April; notice, 22nd July; patent sealed 5th September, 1862.
1878. James Martin, of Perigueux, France, engineer, *Improvements in reaping and mowing machines.* Application dated 26th June; provisional protection, 19th September; notice, 4th November, 1862.
2521. William Harkes, of Lorlock Gralam, Cheshire, agricultural implement maker, *Improvements in machinery for mowing and reaping.* Application dated 13th September; provisional protection, 3rd October, 1862.
1732. J. B. Ingle, of 37, King William-street, London, gentleman, *Improvements in reaping and mowing machines.* (*A communication from America.*) Application dated 10th June; provisional protection, 27th June; notice, 21st October; patent sealed 28th November, 1862.
2589. William McIntyre Cranston, of 58, King William-street, City of London, *Improvements in machinery for reaping and mowing corn and other crops.* Application dated 22nd September; provisional protection, 10th October, 1862.
- *2576. Alfred Vincent Newton, patent agent, Chancery-lane, *Improvements in construction of grain and grass harvesters.* (*A communication from U.S. America.*) Application dated 16th October; provisional protection, 25th October, 1861; patent sealed 11th February, 1862.
- *2989. Alfred Vincent Newton, patent agent, Chancery-lane, *Improvements in mowing and reaping machinery.* (*A communication by William Van Anden, of New York, U.S.*) Application dated 27th November; provisional protection, 13th December, 1861; patent sealed 6th May, 1862.
1262. William E. Newton, 66, Chancery-lane, *Improvements in the construction of mowing and reaping machines.* (*A communication from France.*) Application dated 29th April; provisional protection, 9th May; notice, 26th August; patent sealed 3rd October, 1862.
1690. A. V. Newton, 66, Chancery-lane, patent office, *Improvements in the construction of grain and grass harvesters.* (*An American communication.*) Application dated 4th June; provisional protection, 20th June; notice, 24th June; patent sealed 1st August, 1862.
2218. R. W. Ralph, of Honnington-Grange, near Newport, Salop, *Improvements in reaping machines.* Application dated 7th August: notice, 9th December, 1862.
- *2314. Bernhard Samuelson, of Banbury, engineer, *Improvements in harvesting machines.* Application dated 17th September; provisional protection, 4th October; notice, 10th December, 1861; patent sealed 21st January, 1862.

3031. James Shanks, of Arbroath, county of Forfar, machinist, *Improvements in mowing machines*. Application dated 10th November; provisional protection, 28th November, 1862.
- *2320. Joseph Statham, of Salford, and William Statham, of Openshaw, Lancashire, *Improvements in machinery or apparatus for mowing and reaping*. Application dated 17th September; provisional protection, 4th October, 1861; patent sealed 14th March, 1862.
1793. Samuel Varley, of Sleaford, Lincolnshire, engineer, *Improvements in reaping machines*. Application dated 17th June; provisional protection, 18th July, 1862.
172. John Wallace, Haldane's Mill, Dunbartonshire, agricultural implement maker, *Improvements in reaping machines*. Application dated 23rd January; provisional protection, 7th February; notice, 27th May; patent sealed 15th July, 1862.
2327. Henry Wickens, of Token-House-yard, City of London, solicitor, *Improvements in reaping and mowing machines*. (*A communication from Canada.*) Application dated 18th September; provisional protection, 4th October, 1861; notice, 21st January, 1862.
1573. William Worley, of Ipswich, engineer, *Improvements in reaping machines*. Application dated 26th May; provisional protection, 20th June; notice, 7th October; patent sealed 14th November, 1862.
904. William McIntyre Cranston, of 58, King William-street, London, *Improvements in machinery for cutting corn and other crops*. (*A communication from James Smith Thayer, of New York City, U.S.*) Application dated 31st March; provisional protection, 11th April; notice, 3rd June; patent sealed 7th August, 1862.
511. W. McIntyre Cranston, of 58, King William-street, London, *Improvements in machinery for reaping and mowing*. (*The result partly of a communication from W. A. Wood, of New York.*) Application dated 25th February; provisional protection, 14th March; notice, 3rd June; patent sealed 5th August, 1862.
-
836. Robert Boby, of Bury St. Edmunds, agricultural implement maker, *Improvements in hay-making machines*. Application dated 26th March; provisional protection, 4th April; notice, 22nd July; patent sealed 5th September, 1862.
-
1819. William Malins, of Pershore, Worcestershire, *An improved protective covering for agricultural or other similar purposes*. Application dated 20th June; provisional protection, 11th July.
-
- *2854. Thomas Procter, of Boston, millwright, *Improvements in carriers or stackers, or apparatus for facilitating the stacking of straw, hay, or agricultural produce*. Application dated 13th November; provisional protection, 22nd November, 1861; patent sealed 2nd May, 1862.

THRASHING MACHINES.

- *2353. Joseph Christian Davidson, of Yalding, Kent, farmer, *Improvements in thrashing-machines*. Application dated 20th September; provisional protection, 4th October, 1861; patent sealed 18th March, 1862.

3212. H. L. Emery, of Albany, State of New York, U. S. America, *Improvements in thrashing-machines*. Application dated 1st December; provisional protection, 12th December, 1862.
326. William E. Gedge (John Gedge and Son), of Wellington-street, Strand, patent agent, *An improved portable thrashing and winnowing-machine and apparatus for working the same by horse-power*. (*A communication*.) Application dated 7th February; provisional protection, 21st February, 1862.
387. Richard Hornsby, jun., of Grantham, Lincolnshire, *Improvements in apparatus for thrashing, elevating, cleansing, and separating grain, and in apparatus for elevating straw*. Application dated 13th February; provisional protection, 4th April; notice, 8th April; patent sealed 13th June, 1862.
858. J. H. Johnson, of 47, Lincoln's-inn Fields, gentleman, *Improvements in thrashing-machines*. (*A communication*.) Application dated 27th March; provisional protection, 4th April, 1862.
897. Robert C. Ransome, of Ipswich, *Improvements in thrashing and other machinery where corn or grain is required to be raised from one level to another*. Application dated 31st March; provisional protection, 18th April; notice, 12th August; patent sealed 25th September, 1862.
- *3188. John Smith, jun., and J. B. Higgs, both of Coven, Staffordshire, *Improvements in thrashing-machines, and in mills for grinding, and in raising or moving grain*. Application dated 20th December, 1861; provisional protection, 17th January, 1862; patent sealed 7th March.
1459. John Smith, sen., of Coven, near Wolverhampton, *Improvements in thrashing-machines*. Application dated 14th May; provisional protection, 30th May; notice, 23rd September; patent sealed 11th November, 1862.
- *2313. Weston Tuxford, of Boston, engineer, *Improvements in thrashing-machines and in raising and stacking straw and other agricultural produce*. Application dated 16th September; provisional protection, 8th November, 1861; notice, 21st January, 1862; patent sealed 11th March.
190. Arthur Wallis and Charles Haslam, Basingstoke, Hants, engineers, *Improvements in thrashing-machines*. Application dated 24th January; provisional protection, 7th February, 1862.
2563. Thomas Watts, of Carisbrooke, Isle of Wight, *Improvements in combined thrashing-machines*. Application dated 19th September; provisional protection, 10th October, 1862.
- *2505. J. C. Willsher, of Pelches, county of Essex, farmer, *Improvements in the construction of combined thrashing and dressing-machines*. Application dated 7th October; provisional protection, 1st November, 1861; patent sealed 4th April, 1862.

STRAW AND GRAIN ELEVATORS.

- 475 G. T. Bousfield, of Loughborough-park, Brixton, Surrey, *Improvements in apparatus for elevating hay, straw, and earth*. (*A communication*.) Application dated 22nd February; provisional protection, 4th April; notice, 8th April; patent sealed 23rd May, 1862.

- *2373. Henry Brinsmead, of Ipswich, *Improvements in apparatus for raising and stacking straw and other agricultural produce.* Application dated 23rd September; provisional protection, 4th October, 1861; patent sealed 18th March, 1862.
 - 1921. T. Fellowes and H. Hemfrey, of Spalding, Lincolnshire, *Improvements in apparatus for elevating straw and other agricultural produce.* Application dated 1st July; provisional protection, 18th July.
 - 3035. G. F. Leyster, of Liverpool, engineer, *Improvements in apparatus for elevating or otherwise transmitting grain and other granular substances.* Application dated 10th November; provisional protection, 28th November.
 - 850. James Lock, of Nassington, Northamptonshire, *Improvements in apparatus for raising or elevating straw and crops on to stacks.* Application dated 27th March.
- APPARATUS FOR CLEANING AND DRYING GRAIN.
- 3178. James Bannehr, of Exeter, *Improvements in apparatus for desiccating grain, seeds, &c.* Application dated 18th December, 1861; provisional protection, 3rd January, 1862; patent sealed 13th June.
 - 331. Henry Brinsmead, of Ipswich, Suffolk, machinist, *Improvements in apparatus for moving, elevating, cleaning, and dressing grain.* Application dated 7th February; provisional protection, 28th February, 1862.
 - 1378. John McCann, of Dublin, gentleman, *Improvements in the mode of, and apparatus for, drying, cooling, and cleaning grain.* Application dated 7th May, 1862.
 - 2138. John Ellis, of Witham, Kingston-upon-Hull, corn-factor, *Improvements in apparatus for washing corn and other grain.* Application dated 28th July; provisional protection, 8th August, 1862.
 - 27. W. E. Gedge (Gedge and Son), patent agent, London, *Improvements in apparatus for dressing, cleaning, or sifting grain.* (*A communication.*) Application dated 3rd January; provisional protection, 31st January; notice, 6th May; patent sealed 27th June, 1862.
 - *2302. William Edward Gedge (Gedge and Son, patent agents), *Improved apparatus for drying grain.* (*A communication from France.*) Application dated 16th September, 1861; notice, 21st January, 1862; patent sealed 14th March.
 - *2798. Henry Gould Gibson, of Mark-lane, City of London, *Improvements in apparatus for drying hops, malt, grain, &c., part of which is applicable as a fan or blower.* Application dated 7th November; provisional protection, 22nd November, 1861; patent sealed 6th May, 1862.
 - *3214. John H. Johnson, of 47, Lincoln's-inn-Fields, *Improvements in apparatus for cleaning wheat and other grain.* (*A communication by J. P. Fili, of Paris.*) Application dated 24th December, 1861; provisional protection, 10th January, 1862; patent sealed 27th May.
 - 2701. A. V. Newton, of 66, Chancery-lane, patent agent, *Improvements in apparatus for drying grain.* (*An American communication.*) Application dated 6th October; provisional protection, 17th October, 1862.
 - 2959. W. E. Newton, of 66, Chancery-lane, patent agent, *Improvements in apparatus for drying grain and other substances.* Application dated 1st November, 1862.

502. John Piddington, of 52, Gracechurch-street, London, patent agent, *An improved machine for shelling or thrashing all sorts of grain.* (*A communication.*) Application dated 25th February; provisional protection, 7th March, 1862.
- *1937. Francis Richmond and Henry Chandler, of Salford, and William B. Richie, of Belfast, *An improved sackholder.* Application dated 5th August; provisional protection, 4th October; notice, 10th December, 1861; patent sealed 17th January, 1862.
531. John Smith, sen., of Coven, near Wolverhampton, *Improvements in drying wheat and other grain.* Application dated 26th February; provisional protection, 14th March; notice, 24th June; patent sealed 22nd August, 1862.
- *3118. Augustus Tonnar, of Eupen, Rhenish Prussia, *Apparatus for drying and cleansing malt and other grain and seed intended for brewing, distilling, and agricultural purposes.* Application dated 12th December, 1861; provisional protection, 3rd January, 1862; patent sealed 6th June.
889. Robert Young, of Glasgow, millwright, *Improvements in apparatus for cleansing, separating, washing, and drying grain.* Application dated 31st March; provisional protection, 18th April; notice, 29th July; patent sealed 25th September, 1862.

MEASURING APPARATUS, &c.

1426. Charles James Neale, of High Oakham, Nottinghamshire, gentleman, *Improvements in apparatus for measuring and registering corn and other grain.* Application dated 12th May; provisional protection, 19th September; notice, 23rd September, 1862.
2088. Thomas King, of Truman's brewery, Spitalfields, *Improvements in apparatus for measuring malt, grain, and other granular substances.* Application dated 22nd July; provisional protection, 1st August; notice, 25th November.

CARTS AND OTHER VEHICLES.

2141. Edmund Burnett, of Ashford, Kent, *An improved combined cart and sleigh.* Application dated 28th July; provisional protection, 22nd August; notice, 2nd December, 1862.
2278. J. H. Johnson, of 47, Lincoln's-inn Fields, Middlesex, gentleman, *Improvements in carts and other vehicles.* (*A communication from France.*) Application dated 13th August; provisional protection, 22nd August.
186. James Rock, jun., Hastings, carriage builder, *Improvements in common road carriages.* Application dated 24th January.
2704. Joseph Smith, of Egdon, near Worcester, blacksmith, *An improved screw lynch-pin for carriages and agricultural implements.* Application dated 7th October; provisional protection 17th October.

III. FARM, STABLE, DAIRY, GARDEN, AND OTHER IMPLEMENTS, PROCESSES, &c.

CHAFF-CUTTERS, &c.

2160. Benjamin Bailey, of Leicester, machinist, *Improvements in apparatus for cutting chaff and other vegetable matters, which improvements are*

also applicable to cutting or mowing short or lawn grass. Application dated 30th July; provisional protection, 8th August; notice, 2nd December, 1862.

1391. William Eddington, jun., of Chelmsford, engineer, *Improvements in portable grinding, chaff-cutting, and corn-crushing machinery.* Application dated 9th May; provisional protection, 6th June, 1862.
1750. H. S. Firman and W. J. Williams, of 73, Great Suffolk-street, Southwark, *Improvements in apparatus for cutting up and preparing as food or chaff for animals, or for any other purpose, straw, hay, corn-stalks, roots, and all other similar substances.* (*A communication from the United States of America.*) Application dated 12th June; provisional protection, 20th June, 1862.
868. J. H. Johnson, of 47, Lincoln's-inn Fields, gentleman, *Improvements in chaff-cutters.* Application dated 28th March; provisional protection, 11th April, 1862.

CUTTING AND PULPING MACHINES.

3259. Richard Hornsby, jun., of Grantham, Lincolnshire, *Improvements in apparatus for cutting and pulping turnips and other vegetables.* Application dated 4th December; provisional protection, 26th December; notice, 30th December, 1862.
2374. Reuben Sims (Ficksley, Sims, and Co.), Leigh, Lancashire, *Improvements in machinery or apparatus for pulping, stripping, or slicing turnips and other vegetable substances.* Application dated 27th August; provisional protection, 5th September; notice, 23rd September, 1862.
421. John Whittaker, of Leigh, Lancashire, agricultural implement maker, *Improvements in machinery or apparatus for pulping roots.* Application dated 17th February; provisional protection, 7th March, 1862.
3026. John Whittaker, of Leigh, Lancashire, agricultural implement maker, *Improvements in machinery or apparatus for pulping, stripping, and slicing edible roots for cattle.* Application dated 10th November; provisional protection, 21st November, 1862.

DAIRY UTENSILS, &c.

1987. Ann Bonnell, of Maida-hill, Middlesex, *Improvements in churns.* Application dated 10th July; provisional protection, 25th July, 1862.
2661. W. C. Cambridge, of Bristol, agricultural implement maker, *Improvements in apparatus for washing clothes, applicable also as a churn.* Application dated 1st October; provisional protection, 17th October, 1862.
1480. George Haseltine, of 100, Fleet-street, patent agent, *Improvements in churns.* (*A communication from New York, U. S.*) Application dated 16th May; provisional protection, 30th May; notice, 9th July; patent sealed 4th November, 1862.
- *3139. John Kelly, of Brook Lodge, County Roscommon, *Improvements in the treatment of milk for the manufacture of butter, and in apparatus for the same.* Application dated 13th December, 1861; provisional protection, 3rd January, 1862.

1093. Rupert Rains, of No. 4, Crescent, Bridge-street, Blackfriars, *Improvements in apparatus for freezing, cooling, and churning.* (*A communication.*) Application dated 15th April, 1862.
2686. Francis Watkins, of Smethwick, near Birmingham, *Improvements in apparatus for milking cows.* Application dated 4th October; provisional protection, 17th October, 1862.
1768. Thomas Williams, of 14, Red Lion-street, Clerkenwell, and H. Cox, of 22, Lower-street, Islington, *Improvements in churns, partly applicable to washing-machines.* Application dated 14th June; provisional protection, 27th June; notice, 28th October, 1862.

CURING PROCESSES.

1441. R. A. Boyd, of 11, Duke-street, Southwark, *Improvements in the manufacture of bacon.* Application dated 13th May; provisional protection, 30th May; notice, 16th September, 1862.
- *2666. Robert Andrew Boyd, of Southwark, *Improvements in apparatus for singeing pigs.* Application dated 24th October; provisional protection, 8th November, 1861; notice, 18th February, 1862.
2194. Abraham Denny and E. M. Denny, of Waterford, merchants, *Improvements in the manufacture of bacon.* Application dated 4th August; provisional protection, 22nd August; notice, 16th December, 1862.
2320. T. Wilkinson, of Rathmines, Dublin county, *Improvements in apparatus for singeing pigs.* Application dated 19th August; provisional protection, 5th September, 1862.

STABLE FITTINGS, APPLIANCES FOR HORSE MANAGEMENT, &c.

- *2771. John Ashley, of Bath, LL.D., *Improvements in apparatus for attaching horses to carriages.* Application dated 4th November; provisional protection, 22nd November, 1861; patent sealed 16th April, 1862.
2539. John Golding Bunting, of Trafalgar-square, Charing Cross, patent agent, *An invention of a mechanical horse-break.* Application dated 16th September; provisional protection, 3rd October, 1862.
3047. Allen Thomas Carr, of Soho, Middlesex, *Invention of the addition of a material to the shoes on horses' feet for the purpose of preventing them slipping.* Application dated 5th December, 1861; provisional protection, 3rd January, 1862; patent, 4th February, 1862.
989. James Carrington, of Kensington, groom, *Improvements in paving stables and stable-yards.* Application dated 7th April; provisional protection, 23rd May; notice, 19th April, 1862.
82. Henry Charlton, Birmingham, *Improvements in certain kinds of shoes for mules and horses.* Application dated 11th January; provisional protection, 24th January; notice, 2nd May; patent sealed 13th June, 1862.
337. John Carrington, of Kensington, groom, *Improvements in the construction and fitting-up of stalls and horse-boxes.* Application dated 8th February; provisional protection, 28th February; notice, 17th June; patent sealed 5th August, 1862.
3213. John Coppard, of Hoxton, Middlesex, *Improvements in horse-shoes, to produce the effect of what is termed 'roughing.'* Application dated 1st December; provisional protection, 26th December, 1862.

- *3219. Edward Ede, of St. John's-wood, Middlesex, *Improvements in the construction of horse-shoes*. Application dated 24th December, 1861; provisional protection, 10th January, 1862.
- *2539. Abraham English, of Hatfield, Herts, *Invention of reins or apparatus for preventing horses falling*. Application dated 10th October; provisional protection, 1st November, 1861; patent sealed 25th March, 1862.
- *3035. Wm. E. Gedge (Gedge and Son, patent agents), *Improvements in the manufacture of nosebags, &c., in apparatus connected with such manufacture*. Application dated 4th December; provisional protection, 27th December, 1861; patent sealed 27th May, 1862.
- 567. J. B. Kendall, of Boston, U.S., *An improved horse-shoe*. Application dated 1st March; patent sealed 6th May, 1862.
- 466. Joseph Krasuski, of Paris, professor, *An apparatus for mastering fiery horses*. Application dated 21st February; provisional protection, 14th March, 1862.
- 894. W. B. Lord of Plympton, veterinary-surgeon, Royal Artillery, and F. H. Gilbert, of Brixton, Surrey, gentleman, *An improved hame-slip for suddenly releasing horses and other cattle from their harness, and for other purposes*. Application dated 31st March; provisional protection, 11th April; notice, 12th August; patent sealed 25th September, 1862.
- 745. M. A. F. Mennons, of Paris, patent agent, *Improvements in means of arresting headstrong or runaway horses*. (*A communication*.) Application dated 18th March; provisional protection, 21st March; notice, 1st July; patent sealed 7th August, 1862.
- 1894. M. A. F. Mennons, of Paris, patent agent, *Improved apparatus for the prevention and reduction of synovial and other swellings or tumours in the limbs of horses*. (*A communication*.) Application dated 28th June; protection on complete specification, 4th July; notice, 16th September; patent sealed 24th October, 1862.
- 928. A. V. Newton, of 66, Chancery-lane, patent agent, *Improvements in bits for taming or subduing vicious horses and breaking colts*. (*A communication from America*.) Application dated 2nd April; provisional protection, 11th April; notice, 10th June; patent sealed 15th July, 1862.
- 2089. George Payne, of Grantham, shoeing-smith, *Improvements in horse-shoes*. Application dated 22nd July; provisional protection, 15th August, 1862.
- 2794. H. A. Rémère, of Paris, harness maker, *An improved horse-collar*. Application dated 16th October; provisional protection, 31st October; notice, 11th November, 1862.
- 2456. William Wills, of Ryder's-court, Leicester-square, Middlesex, *Improvements in horse-shoes and in the method of fastening the same*. Application dated 5th September; provisional protection, 19th September, 1862.

BRICK AND TILE MACHINES.

- 2973. R. A. Brooman, of 166, Fleet-street, patent agent, *Improvements in machinery for moulding and compressing artificial fuel, peat, bricks, tiles, and other substances*. (*A French communication*.) Application dated 3rd November; provisional protection, 21st November, 1862.

3303. Peter Effertz, of Manchester, engineer, *Improvements in machinery or apparatus for making bricks, tiles, drain pipes, and other similar articles.* Application dated 9th December; provisional protection, 26th December, 1862.
1835. Henry Gonnon, of Saint Nazaire, France, *Improvements in machinery for making bricks.* Application dated 21st June; provisional protection, 19th September, 1862.
96. George Hewitt, Ipswich, *Improvements in apparatus used in the manufacture of drain tiles.* Application dated 13th January; provisional protection, 24th January, 1862.
2696. Samuel Holland, of Oldbury, Worcestershire, machinist, *Improvements in machinery for the manufacture of bricks, drain, sanitary, and other pipes, tiles, &c., from clay, marl, and other plastic substances.* Application dated 6th October; provisional protection, 17th October, 1862.
2450. John Platt and William Richardson, of Oldham, Lancashire, engineers, *Improvements in the preparation of clay for the manufacture of bricks, tiles, &c.* Application dated 4th September: provisional protection, 26th December, 1862.
1322. Charles Schlickeysen, of Berlin, Prussia, machinist, *Improvements in machinery for moulding bricks, tiles, pipes, and turf.* Application dated 3rd May; provisional protection, 16th May; notice, 9th September; patent sealed 24th October, 1862.
269. William Smith, of Bury, Lancashire, *Improvements in machinery for the manufacture of bricks, tiles, or other articles of a similar character.* Application dated 1st February; provisional protection, 28th February; notice, 3rd June, 1862.
3116. Charles Stevens (Stevens and Henderson), of 31, Charing Cross, patent agent, *An improved brick-making machine. (A French communication.)* Application dated 20th November; provisional protection, 28th November, 1862.
1813. William Thomson, of Thorney, near Peterborough, *Improvements in machinery for making bricks, tiles, and other articles.* Application dated 19th June; provisional protection, 11th July, 1862.
1121. Frederick Tolhausen, of Paris, patent agent, *Improved machine for making bricks, tiles, &c. (A communication from Victor Duprat.)* Application dated 17th April; provisional protection, 2nd May, 1862.

MANUFACTURE OF PEAT.

- *2412. William Clark, of 53, Chancery Lane, patent agent, *Improvements in the manufacture of peat. (A French communication.)* Application dated 26th September, 1861; patent sealed 21st March, 1862.
- *2058. William H. Smith, M.D., of Philadelphia, U.S. (now of London), *Improvements in the preparation, application, and manufacture of peat.* Application dated 19th August, 1861; patent sealed 14th February, 1862.

WIRE FENCING.

1854. William Bayliss (W. and M. Bayliss and Co.), of Wolverhampton, manufacturers, *An improved strainer for straining and tightening wire for fencing, &c.* Application dated 24th June; provisional protection, 4th July, 1862.

- 241. George Bedson, of Manchester, manager, *Improvements in wire fences*. Application dated 29th January; provisional protection, 14th February, 1862.
- 292. Paul Gardilanne, of Dax, Department of the Landes, France, gentleman, *Improvements in the manufacture of metallic wire fencing*. Application dated 4th February; provisional protection, 21st February, 1862.
- 2516. John Rowell, of Aberdeen, manufacturer, *Improvements in pillars and apparatus for straining wire*. Application dated 12th September; notice, 21st October, 1862.

HORTICULTURAL APPLIANCES.

- 1627. R. Nicholson, of Copt Hewick, Ripon, Yorkshire, machine-maker, *Improvements in the construction of lawn mowing machines*. Application dated 30th May; provisional protection, 27th June, 1862.
- 3244. Alexander Morton, of Arbroath, county of Forfar, engineer, *Improvements in lawn mowing machines*. Application dated 3rd December; provisional protection, 19th December, 1862.
- *3201. T. and W. Green and R. Mathers, all of Leeds, *Improvements in lawn mowing, rolling, and collecting machines*. Application dated 31st December, 1861; provisional protection, 10th January, 1862; patent sealed 18th March.
- 2644. The Rev. H. Moule, of Fordlington, Dorset, *Improvements in heating frames and the beds of hothouses, also in heating hothouses and other buildings used for growing plants, &c.* Application dated 29th September; provisional protection, 10th October, 1862.
- 482. Robert Foster, jun., of Beaston, Nottinghamshire, *Improvements in the construction of buildings or erections for horticultural or other purposes*. Application dated 22nd February; provisional protection, 21st March; notice, 1st July, 1862.
- 592. G. H. and H. R. Cottam, of the St. Pancras Iron Works, Old St. Pancras-road, Middlesex, *Improvements in horticultural buildings and other glazed structures*. Application dated 4th March; provisional protection, 28th March; notice, 8th July; patent sealed 29th August, 1862.

MANAGEMENT OF ROADS AND STREAMS, &c.

- 1676. John Fincham, of Mildenhall, Suffolk, machinist, *An arrangement of mechanism useful for facilitating the repairing of roads and also applicable to the tilling of the land*. Application dated 3rd June; provisional protection, 15th August, 1862.
- 4. Thomas Hall, Odiham, Hants, *An invention proposed to be termed a weed dredging machine*. Application dated 1st January; provisional protection, 24th January; notice, 22nd April, 1862.
- 1714. James Lovegrove, of Hackney, Middlesex, surveyor, *Improvements in apparatus for inspecting small sewers and drains, and removing obstructions therein*. Application dated 9th June; provisional protection, 20th June, 1862.
- 1659. C. H. Roeckner, of Bristol, *An improved method of constructing cofferdams and other similar structures for excluding or keeping back the flow of water and preventing inundations*. Application dated 2nd

June; provisional protection, 27th June; notice, 14th October, 1862.

2359. C. H. Roeckner, of Bristol, *Improvements in syphons for discharging or drawing off large bodies of water, and in the mode of charging, flaring, and constructing the same, whereby they are rendered perfectly self-acting.* Application dated 23rd August; provisional protection, 5th September, 1862.

ARTIFICIAL MANURES, TREATMENT OF SEWAGE, &c.

2097. William Clarke, of 53, Chancery-lane, patent agent, *Improvements in the manufacture of manure. (A communication from the Manager of the Western Lime-burning Company, Paris.)* Application dated 23rd July; provisional protection, 22nd August; notice, 26th August; patent sealed 17th October, 1862.
2712. John Beale, of Maidstone, Kent, and Mary Ann Beale, of Barnsbury, Middlesex, *Improvements in the preparation or manufacture of manure.* Application dated 7th October; provisional protection, 24th October, 1862.
908. William Clark, of 53, Chancery-lane, engineer and patent agent, *Improvements in the manufacture of manure. (A communication from L. E. Lavigne, of Paris.)* Application dated 1st April; provisional protection, 11th April; notice, 22nd July; patent sealed 19th September, 1862.
2062. Joseph Daniels, of Leigh, Lancashire, *Improvements in artificial manure.* Application dated 22nd July; provisional protection, 1st August; notice, 25th November, 1862.
2073. A. M. Fell, of Anchanard, in the county of Linlithgow, chemist, *Improvements in obtaining or manufacturing sulphate of ammonia and manure.* Application dated 21st July; provisional protection, 15th August, 1862.
1623. William Footman, of No. 5, Great Queen-street, Westminster, *Improvements in the treatment and use of sewage and liquid manures, and in reservoirs and pipes to be used therein.* Application dated 30th May; provisional protection, 27th June, 1862.
1244. William T. Glidden, of Massachusetts, U.S., *A new and useful method of restoring phosphatic guano. (A communication.)* Application dated 29th April; protection on complete specification, 2nd May; notice, 6th May; patent sealed 19th September.
2669. John Harross, of Manchester, chemist, and James Wadsworth, of Salford, near Manchester, machinist, *Improvements in deodorising refuse, organic, faecal, and urinous matters; and in a method of utilising coal and other ashes; and in machinery or apparatus connected therewith for producing a portable manure therefrom.* Application dated 3rd October; provisional protection, 17th October, 1862.
- *2229. Charles Fenton Kirkman, of Lambeth, *Improvements in obtaining manure from sewerage and in apparatus employed therein.* Application dated 6th September; provisional protection, 20th September, 1861; notice, 14th January, 1862.
338. M. A. F. Mennons, of 39, Rue de l'Echiquier, Paris, patent agent, *Improvements in the treatment of coprolites and other fossil phosphates of lime. (A communication.)* Application dated 10th February; provisional protection, 21st February; notice, 20th May; patent sealed 18th July, 1862.

- 378. M. A. F. Mennons, of Paris, patent agent, *Improvements in the disinfection of animal excretions, and in the extraction therefrom of fertilising elements.* (A communication.) Application dated 13th February; patent sealed 29th July, 1862.
- 1189. William E. Newton, of 66, Chancery-lane, civil engineer, *An improved fertilising composition.* (An American communication,) Application dated 23rd April; provisional protection, 2nd May; notice, 26th August; patent sealed 3rd October, 1862.
- 2201. John R. Nicholl, of Streatham, Surrey, clerk, *Improvements in the means of, and apparatus for, utilising and disposing of the sewage of towns and villages.* Application dated 5th August; provisional protection, 22nd August, 1862.
- *3265. Thomas Pickford, Fenchurch-street, merchant, *Improvements in the manufacture of manure.* Application dated 31st December, 1861.
- 3449. John Platt and William Richardson, both of Oldham, Lancashire, engineers, *Improvements in machinery or apparatus for disintegrating or pulverising artificial manures, chemical salts, and other substances.* Application dated 24th December, 1862.
- 587. Bridge Standen, of Salford, near Manchester, chemist, *Improvements in the manufacture of portable manure, and in machinery or apparatus to be employed therein.* Application dated 4th March; provisional protection, 14th March; notice, 18th March; patent sealed 6th May, 1862.
- *2159. Alexander Taille, of Agen, France, *An improved manufacture of manure.* Application dated 30th August; provisional protection, 13th September, 1861; notice, 7th January, 1862; patent sealed 18th February.
- 3361. John Louis William Thudichum, of Kensington, doctor of medicine, *Improvements in collecting human excreta and in the apparatus or means employed therein.* Application dated 16th December; provisional protection, 26th December, 1862.
- *2525. Thomas Tidmarsh, of Dorking, Surrey, agriculturist, *An improved artificial manure.* Application dated 9th October; provisional protection, 25th October, 1861; patent sealed 1st April, 1862.

CONDIMENTAL FOOD.

- 1811. E. J. Davis, of West Smithfield, in the City of London, *Improvements in treating and preparing food for horses and other animals.* Application dated 19th June; provisional protection, 11th July; notice, 21st October; patent sealed 5th December, 1862.
- *2878. James Spratt, of Camden Town, *Improvements in the preparation of food for hogs, dogs, cats, and poultry, and in apparatus for the same.* Application dated 15th November; provisional protection, 29th November, 1861; patent sealed 13th May, 1862.*
- 891. William Tyler, of Birmingham, corn dealer, *A new or improved mixture or composition for feeding dogs and other animals and poultry.* Application dated 31st March; provisional protection, 18th April; notice, 12th August; patent sealed 25th September, 1862.
- 3273. George Wright, of Peckham Rye, Surrey, *Improvements in the preparation and manufacture of food for cattle.* Application dated 6th December; provisional protection, 26th December, 1862.

MISCELLANEOUS.

- *3242. Thomas Bright, of Carmarthen, *Improvements in machinery for cutting hay, straw, &c.* Application dated 27th December, 1861; provisional protection, 10th January, 1862; patent sealed 17th June.
- 2106. J. G. Clarke, of Brackley, Northamptonshire, *Improvements in scythes.* Application dated 24th July; provisional protection, 1st August; notice, 2nd December, 1862.
- 1895. Thomas King, of Grafton, Warwickshire, farmer, and John King, of Chadshunt, farmer, *Improvements in agricultural implements.* Application dated 28th June; provisional protection, 18th July, 1862.
- 1435. P. M. Lopez, of Paris, gentleman, *Improvements in apparatus for sowing wheat or other grain or seeds.* Application dated 13th May; provisional protection, 30th May; patent sealed 7th November, 1862.
- *1982. Charles Peters Moody, of Corton Denham, Somerset, *Improvements in construction of gates.* Application dated 9th August; provisional protection, 23rd August; notice, 17th December, 1861; patent sealed 4th February, 1862.
- 1664. W. E. Newton, of 66, Chancery-lane, civil engineer, *Improvements in handles of shovels, spades, dung forks, and other analogous articles. (A communication from the United States of America.)* Application dated 2nd June; provisional protection, 20th June; notice, 24th June; patent sealed 1st August, 1862.
- 1923. W. E. Newton, of the Patent Office, 66, Chancery-lane, *Improvements in machinery for washing wool. (A communication from the United States of America.)* Application dated 1st July; provisional protection, 18th July; notice, 11th November; patent sealed 16th December, 1862.
- 350. W. H. Weaver, of Edington, Salop, agricultural engineer, and Charles Gall, of Bridgnorth, Salop, engineer, *Improved machinery for agricultural purposes.* Application dated 11th February; provisional protection, 14th March, 1862.

END OF VOL. XXIV.

Royal Agricultural Society of England.

1863.

President.

VISCOUNT EVERSLEY.

Trustees.

ACLAND, SIR THOMAS DYKE, Bart., *Killerton Park, Exeter, Devonshire.*
BERNERS, Lord, *Keythorpe Hall, Leicester.*
BRAMSTON, THOMAS WILLIAM, M.P., *Skreens, Chelmsford, Essex.*
CHALLONER, Colonel, *Portnall Park, Staines, Middlesex.*
FEVERSHAM, Lord, *Helmsley, York.*
MARLBOROUGH, Duke of, *Blenheim Park, Oxford.*
PORTMAN, Lord, *Bryanston, Blandford, Dorset.*
POWIS, Earl of, *Powis Castle, Welshpool, Montgomeryshire.*
RUTLAND, Duke of, *Belvoir Castle, Grantham, Lincolnshire.*
SHELLEY, Sir JOHN VILLIERS, Bart, M.P., *Maresfield Park, Sussex.*
SPEAKER, The Rt. Hon. the, *Ossington, Newark-on-Trent, Notts.*
THOMPSON, HARRY STEPHEN, M.P., *Kirby Hall, York.*

Vice-Presidents.

ASHBURTON, Lord, *The Grange, Alresford, Hampshire.*
BARKER, THOMAS RAYMOND, *Hambledon, Henley-on-Thames, Oxfordshire.*
CHICHESTER, Earl of, *Stanmer Park, Lewes, Sussex.*
DOWNHIRE, Marquis of, *East Hampstead Park, Bracknell, Berkshire.*
EGMONT, Earl of, *Cowdray Park, Petworth, Sussex.*
EVERSLEY, Viscount, *Heckfield Place, Winchfield, Hants.*
EKETER, Marquis of, *Burleigh House, Stamford, Lincolnshire.*
HILL, Viscount, *Hawkstone Park, Salop.*
HOBBS, W. FISHER, *Boxted Lodge, Colchester, Essex.*
JOHNSTONE, Sir JOHN V. B., Bart., M.P., *Hackness Hall, Scarborough, Yorkshire.*
MILES, Sir WILLIAM, Bart., M.P., *Leigh Court, Bristol, Somersetshire.*
WALSINGHAM, Lord, *Merton Hall, Thetford, Norfolk.*

Other Members of Council.

ACLAND, THOMAS DYKE, *Spyndoncote, Exeter, Devonshire.*
AMOS, CHARLES EDWARDS, *Greenfield House, Sutton, Surrey.*
ARKWRIGHT, J. HUNGERFORD, *Hampton Court, Leominster, Herefordshire.*
BARNETT, CHARLES, *Stratton Park, Biggleswade, Bedfordshire.*
BARTHOLOPP, NATHANIEL GEORGE, *Hacheaton, Wickham Market, Suffolk.*
BRANDRETH, HUMPHREY, *Houghton Hall, Dunstable, Bedfordshire.*
BULLER, JAMES WENTWORTH, M.P., *Downes, Crediton, Devonshire.*
CANTRELL, CHARLES S., *Riding Court, Datchet, Bucks.*
CATHCART, Earl, *Thirsk, Yorkshire.*
CAYENDISH, Hon. WILLIAM, M.P., *Latimer, Chessham, Bucks.*
COTTON, Colonel the Hon. W. H. S., *Cherry Hill, Malpas, Cheshire.*

VOL. XXIV.

b

- DENT, J. D., M.P., *Ribston Hall, Wetherby, Yorkshire.*
 DRUCE, JOSEPH, *Eynsham, Oxford.*
 EXALL, WILLIAM, *Reading, Berkshire.*
 GIBBS, B. T. BRANDRETH, *Halfmoon Street, Piccadilly, London, W.*
 HAMOND, ANTHONY, *Westacre Hall, Brandon, Norfolk.*
 HOLLAND, EDWARD, M.P., *Dumbleton Hall, Evesham, Worcestershire.*
 HOOD, Major-Gen. the Hon. A. NELSON, *Cumberland Lodge, Windsor, Berkshire.*
 HOSKYNs, CHANDOS WREN, *Harewood, Ross, Herefordshire.*
 HUDSON, JOHN, *Castleacre Lodge, Brandon, Norfolk.*
 HUMBERSTON, PHILIP STAPYLTON, M.P., *Mollington, Chester, Cheshire.*
 HUTTON, WILLIAM, *Gate Burton, Gainsboro', Yorkshire.*
 JONAS, SAMUEL, *Chriehall Grange, Saffron Walden, Essex.*
 KERRISON, Sir EDWARD CLARENCE, Bart., M.P., *Brome Hall, Scole, Norfolk.*
 LAWES, JOHN BENNET, *Bothamsted, St. Albans, Herts.*
 LAWRENCE, CHARLES, *Cirencester, Gloucestershire.*
 LEIGH, Lord, *Stoneleigh Abbey, Warwickshire.*
 MACDONALD, Sir ARCHIBALD KEPPEL, Bart., *Woolmer Lodge, Liphook, Hants.*
 MILWARD, RICHARD, *Thurgarton Priory, Southwell, Notts.*
 PAIN, THOMAS, *Laverstock Hall, Salisbury, Wilts.*
 POPE, EDWARD, *Great Toller, Maiden Newton, Dorset.*
 RANDELL, CHARLES, *Chadbury, Evesham, Worcestershire.*
 RIDGEN, WILLIAM, *Hove, Brighton, Sussex.*
 SANDAY, WILLIAM, *Holmepierrepont, Notts.*
 SHUTTLEWORTH, JOSEPH, *Hartsholme Hall, Lincoln.*
 SMITH, ROBERT, *Emmett's Grange, Southmolton, Devon.*
 STANHOPE, JAMES BANKS, M.P., *Revesby Abbey, Boston, Lincolnshire.*
 STRADBROKE, Earl of, *Henham Park, Wangford, Suffolk.*
 TORR, WILLIAM, *Aylesby Manor, Great Grimsby, Lincolnshire.*
 TOWNELEY, Lieut.-Colonel CHARLES, *Towneley Park, Blackburn, Lancashire.*
 TREDEGAR, Lord, *Tredegar, Newport, Monmouthshire.*
 TURNER, GEORGE, *Beacon Downes, Exeter, Devonshire.*
 VERNON, Hon. AUGUSTUS H., *Orgreave Hall, Lichfield, Staffordshire.*
 WALLIS, OWEN, *Overstone Grange, Northampton.*
 WELLS, WILLIAM, *Redleaf, Penshurst, Kent.*
 WESTERN, THOMAS BURCH, *Feliz Hall, Kelvedon, Essex.*
 WILSON, HENRY, *Stowlangtoft Hall, Bury-St.-Edmunds, Suffolk.*
 WILSON, Professor, *Iwer, Uxbridge, Bucks.*
 WYNN, Sir WATKIN WILLIAMS, Bart., M.P., *Rhuabon, Denbighshire.*

Secretary.

H. HALL DARE, 12, *Hanover Square, London, W.*

-
- Consulting-Chemist*—Dr. AUGUSTUS VOELCKER, *Royal Agricultural College, Cirencester.*
Veterinary-Inspector—JAMES BEART SIMONDS, *Royal Veterinary College, N.W.*
Consulting Engineer—JAMES EASTON, or C. E. AMOS, *Grove, Southwark, S.E.*
Seedsman—THOMAS GIBBS and Co., *Corner of Halfmoon Street, Piccadilly, W.*
Publisher—JOHN MURRAY, 50, *Albemarle Street, W.*
Bankers—THE LONDON AND WESTMINSTER BANK, *St. James's Square Branch, S.W.*

STANDING COMMITTEES FOR 1863.

Finance Committee.

HOOD, Hon. Maj.-Gen. A. NELSON,
Chairman.
BARNETT, CHARLES.

BRAMSTON, T. W., M.P.
HOBBS, WM. FISHER.
TORR, WILLIAM.

House Committee.

THE PRESIDENT.
CHAIRMAN of Finance Committee.
CAVENDISH, Hon. W., M.P.
SHELLEY, Sir J. V., Bt., M.P.

BRANDRETH, HUMPHREY.
CHALLONER, Colonel.
GIBBS, B. T. BRANDRETH.
HOBBS, WM. FISHER.

Journal Committee.

THOMPSON, H. S., M.P., Chairman.
CATHCART, Earl.
SPEAKER, The Rt. Hon. THE.
SHELLEY, Sir J. V., Bt., M.P.
JOHNSTONE, Sir J. V. B., Bt., M.P.
KERRISON, Sir E. C., Bt.

MACDONALD, Sir A. K., Bt.
ACLAND, T. DYKE.
HOLLAND, ED., M.P.
HOSKYNS, C. WREN.
MILWARD, RICHARD.
WALLIS, OWEN.

Chemical Committee.

VERNON, Hon. A. H.
JOHNSTONE, Sir J. V. B., Bt., M.P.
MILES, Sir WM., Bt., M.P.
ACLAND, T. DYKE.
ARKWRIGHT, J. H.
DAUBENT, Dr.
DENT, J. D., M.P.
HOLLAND, ED., M.P.

HOSKYNS, C. WREN.
HUDSON, JOHN.
HUMBERSTON, P. S., M.P.
HUXTABLE, Ven. Archdeacon.
LAWES, J. B.
THOMPSON, H. S., M.P.
WELLS, WILLIAM.

Veterinary Committee.

SHELLEY, Sir J. V., Bt., M.P.
JOHNSTONE, Sir J. V. B., Bt., M.P.
MILES, Sir WM., Bt., M.P.
BARKER, THOS. RAYMOND.
CHALLONER, Colonel.
GIBBS, B. T. BRANDRETH.
HAMOND, ANTHONY.

HOBBS, WM. FISHER.
PAIN, THOS.
SIMONDS, Professor.
SPOONER, Professor.
THOMPSON, H. S., M.P.
WELLS, WILLIAM.

Stock-Prizes Committee.

WALSINGHAM, Lord.
SHELLEY, Sir J. V., Bt., M.P.
HOOD, Hon. Maj.-Gen. A. NELSON.
BARNETT, CHARLES.
BARTHOLOPE, NATHANIEL G.
DRUCE, JOSEPH.
GIBBS, B. T. BRANDRETH.
HOBBS, WM. FISHER.
HOLLAND, ED., M.P.
HUDSON, JOHN.

JONAS, SAMUEL.
MILWARD, RICHARD.
PAIN, THOMAS.
POPE, EDWARD.
RANDELL, CHAS.
RIGDEN, WM.
SMITH, ROBERT.
SIMONDS, Professor.
TORR, WILLIAM.
TURNER, GEORGE.

Implement Committee.

CAVENDISH, Hon. W., M.P.
 HOOD, Hon. Maj.-Gen. A. NELSON.
 VERNON, Hon. A. H.
 SHELLEY, Sir J. V., Bt., M.P.
 MACDONALD, Sir A. K., Bt.
 MILES, Sir Wm., Bt., M.P.
 AMOS, C. E.
 BARNETT, CHARLES.
 CANTRELL, CHAS. S.
 CHALLONER, Colonel.

EXALL, WILLIAM.
 GIBBS, B. T. BRANDRETH.
 HAMOND, ANTHONY.
 HOBBS, WM. FISHER.
 HOSKYNES, C. WREN.
 SHUTTLEWORTH, JOSEPH.
 THOMPSON, H. S., M.P.
 TORR, WILLIAM.
 WALLIS, OWEN.
 WILSON, Professor.

General Worcester Committee.

PORTMAN, Lord, Chairman.
 POWIS, Earl of.
 LEIGH, Lord.
 NORTHWICK, Lord.
 TREDEGAR, Lord.
 WALSHINGHAM, Lord.
 CAVENDISH, Hon. W., M.P.
 HOOD, Hon. Maj.-Gen. A. NELSON.
 LYGON, Hon. F., M.P.
 VERNON, Hon. A. H.
 PAKINGTON, Sir John, Bart., M.P.
 WYNN, Sir WATKIN W., Bart., M.P.
 ARKWRIGHT, J. HUNGERFORD.
 BARNETT, CHARLES.
 BRAMFTON, T. W., M.P.
 CANTRELL, CHARLES S.

CHALLONER, Colonel.
 DENT, J. D., M.P.
 FENTON, WILLIAM.
 GIBBS, B. T. BRANDRETH.
 HOBBS, WM. FISHER.
 HOLLAND, E., M.P.
 HOSKYNES, C. WREN.
 LAKIN, HENRY.
 MILWARD, RICHARD.
 PAIN, THOMAS.
 RANDELL, CHARLES.
 ROYDS, A. H.
 SHUTTLEWORTH, JOSEPH.
 TORR, WILLIAM.
 WORCESTER, Mayor of.

. The PRESIDENT, TRUSTEES, and VICE-PRESIDENTS are Members *ex officio* of all Committees.

MEMORANDA.

ADDRESS OF LETTERS.—The Society's office being situated in the postal district designated by the letter **W**, members, in their correspondence with the Secretary, are requested to subjoin that letter to the usual address.

GENERAL MEETING in London, May 22, 1863, at Twelve o'clock.

MEETING at Worcester, commencing July 20, 1863.

GENERAL MEETING in London, in December, 1863.

MONTHLY COUNCIL (for transaction of business), at 12 o'clock on the first Wednesday in every month, excepting January, September, and October: open only to Members of Council and Governors of the Society.

WEEKLY COUNCIL (for practical communications), at 12 o'clock on all Wednesdays in February, March, April, May, June, July, November, and December, excepting the first Wednesday in each of those months, and during adjournment: open to all Members of the Society, who are particularly invited by the Council to avail themselves of this privilege.

ADJOURNMENTS.—The Council adjourn over Passion and Easter weeks, when those weeks do not include the first Wednesday of the month; from the first Wednesday in August to the first Wednesday in November; and from the first Wednesday in December to the first Wednesday in February.

DISEASES OF Cattle, Sheep, and Pigs.—Members have the privilege of applying to the Veterinary Committee of the Society; and of sending animals to the Royal Veterinary College, on the same terms as if they were subscribers to the College.—(A statement of these privileges will be found in the present Appendix.)

CHEMICAL ANALYSIS.—The privileges of Chemical Analysis enjoyed by Members of the Society will be found stated in the Appendix of the present volume.

LOCAL CHEQUES.—Members are particularly requested not to forward Country Cheques for payment in London; but London Cheques, or Post-office Orders on Vere-street (payable to **H. HALL DARE**), in lieu of them. All Cheques are required to bear upon them a penny draft or receipt stamp, which must be cancelled in each case by the initials of the drawer. They may also conveniently transmit their Subscriptions to the Society, by requesting their Country Bankers to pay (through their London Agents) the amount at the Society's Office (No. 12, Hanover Square, London), between the hours of ten and four, when official receipts, signed by the Secretary, will be given for such payments.

NEW MEMBERS.—Every candidate for admission into the Society must be proposed by a Member; the proposer to specify in writing the full name, usual place of residence, and post-town, of the candidate, either at a Council meeting, or by letter addressed to the Secretary.

PACKETS BY POST.—Packets not exceeding two feet in length, width, or depth, consisting of written or printed matter (but not containing letters sealed or open), if sent without envelopes, or enclosed in envelopes open at each end, may be forwarded by the inland post, if stamped, at the following rates:—

For a packet not exceeding	4 ounces	(or quarter of a pound)	. . .	1 penny
" "	8 "	(or half a pound)	. . .	2 pence.
" "	16 "	(or one pound)	. . .	4 "
" "	24 "	(or one pound and a half)	. . .	6 "
" "	32 "	(or two pounds)	. . .	8 "

[And so on in the proportion of 8 ounces for each additional 32.]

* * Members may obtain on application to the Secretary copies of an Abstract of the Charter and Bye-Laws, of a Statement of the General Objects, &c., of the Society, of Chemical and Veterinary Privileges, and of other printed papers connected with special departments of the Society's business.

Royal Agricultural Society of England.

GENERAL MEETING,

12, HANOVER SQUARE, FRIDAY, MAY 22, 1863.

REPORT OF THE COUNCIL.

THE Council have the satisfaction of reporting favourably of the progress made by the Society in the attainment of its practical and useful objects.

The number of its members at the present time differs only by 6 from the numbers at the date of the last general meeting, 205 names having been removed by death or otherwise from the list, while 211 new members have within the last 5 months been elected into the Society, which now consists of—

80 Life Governors,
88 Annual Governors,
1,263 Life Members,
3,735 Annual Members, and
17 Honorary Members,

making a total of 5,183.

Mr. Bowly, of Siddington House, Cirencester, has been elected a Member of Council in the place of the late Mr. Jonas Webb.

The funds of the Society are in a highly satisfactory state; every claim against it has been regularly discharged as it has become due; and while 16,488*l.* 17*s.* 10*d.* remains invested in the New Three per Cents., an ample cash balance is available for current purposes in the hands of the bankers. A deposit account having been opened with the bankers, the Society will receive interest on the funds which accumulate in the early part of the year, and will not be required till the show-yard is erected.

The Council have to report the favourable progress of the preparations for the country meeting of the Society, to be held this year in the city of Worcester, in the week commencing on Monday, the 20th of July, which will be the day on which the judges will award the prizes in the classes of live stock. The show and trial-yards will be open as follows :—

Wednesday, July 15.—The trial-yard open from noon till 6 P.M.

Thursday, Friday, and Saturday; July 16, 17, and 18.—The trial-yard open from 9 A.M. till 6 P.M.

Monday, July 20.—Cattle-yard open from 8 A.M., when the judges will commence inspecting the live-stock and making their awards; the implement-yard open from 8 A.M.; the show-yards will close at 6 P.M.

Tuesday, Wednesday, Thursday, and Friday; July 21, 22, 23, and 24.—The general show open from 6 A.M. to 6 P.M.

Mr. Dent, M.P., has accepted the office of steward of stock; and Sir Archibald Macdonald that of steward of implements, in the place of the Hon. A. Vernon, resigned. The entries for implements are more numerous than in any previous year in all the three departments of shedding, seed and model sheds, and machinery in motion.

Papers have been read at the weekly meetings by Mr. Taylor, of 88, Parliament Street, on Materials for Cottage Building; by Mr. Bailey Denton, on the Effect of Under-drainage on the Rivers and Arterial Channels of the Country; on the Adulteration of Oilcakes, by Professor Voëlcker; on Animal Parasites, by Professor Simonds; and by Mr. Ruck, on Steam Cultivation.

The Council have decided, subject to the usual conditions, to hold the Society's country meeting next year at Newcastle-upon-Tyne.

The country meeting in the year 1865 will be held in the district comprising the counties of Cornwall, Devon, Dorset, and Somerset.

By Order of the Council,

H. HALL DARE,
Secretary.

ROYAL AGRICULTURAL

DR.

HALF-YEARLY CASH ACCOUNT

To Balance in hand, 1st January, 1863:—	£.	s.	d.	£.	s.	d.
Bankers	349	2	8			
Secretary	33	3	9			
				382	6	5
To Income, viz.:—						
Dividends on Stock	238	1	2			
Subscriptions:—	£.	s.	d.			
Governors' Annual	390	0	0			
Members' Life-Compositions ..	450	0	0			
Members' Annual	2994	5	0	3,834	5	0
Journal:—						
Sales	116	19	6			
Advertisements	23	16	4	140	15	10
Veterinary:—						
Sale of Pamphlets	5	1	3			
Sale of Wool	6	3	0	4,224	6	3
To London Show .. .. .	..	..	..	2	6	0
To Worcester Meeting .. .. .	..	..	..	3,618	0	0
				£ 8,226	18	8

BALANCE-SHEET,

LIABILITIES.					£.	s.	d.	£.	s.	d.
To Capital:										
Surplus, 31st December, 1862					21,557	18	2			
Surplus of Income over Expenditure during the Half-year, viz:—										
Income	4224	6	3							
Expenditure	1966	18	7		2,257	7	8	23,815	5	10
To London Show:—										
Difference between Receipts and Expenditure, the latter exceeding the former by .. .. .					..	..		3,584	10	9
								£20,230	15	1

(Signed)

A. N. HOOD, on behalf of Finance Committee.

SOCIETY OF ENGLAND.

FROM 1ST JANUARY TO 30TH JUNE, 1863.

CR.

By Expenditure:—	£.	s.	d.	£.	s.	d.	£.	s.	d.
Establishment—									
Official Salaries and Wages ..	327	6	0						
House Expenses, Taxes, &c. ..	257	15	2						
Journal:—				585	1	2			
Printing	386	1	0						
Stitching	65	0	0						
Delivery, Advertising, &c. . .	109	18	3						
Prize Essays	25	0	0						
Other Contributions	5	10	0						
Editor's Salary	250	0	0						
Chemical:—				841	9	3			
Consulting Chemist's Salary ..	150	0	0						
Grant for Investigations, 1863 ..	200	0	0						
Veterinary:—				350	0	0			
Grant to Royal Veterinary College				100	0	0			
Stock:—Brokerage, &c.				9	13	6			
Postage and Carriage				43	18	0			
Advertisements				13	3	6			
Sundries				10	16	10			
Subscriptions returned (paid in error)				3	0	0			
Wool at International Exhibition				9	16	4			
							1,966	18	7
By London Show							582	16	1
By Worcester Meeting							1,090	13	4
Total Payments							3,640	8	0
By Deposit with London and Westminster Bank ..							2,000	0	0
By Balance in hand:—									
Bankers				2585	1	11			
Secretary				1	8	9			
							2,586	10	8
							£8,226	18	8

30TH JUNE, 1863.

ASSETS.	£.	s.	d.	£.	s.	d.
By Cash in hand	2,586	10	8			
By Deposit Account, London and Westminster Bank	2,000	0	0			
By New 3 per cent. Stock, 16,488l. 17s. 10d. cost ..	15,881	11	1			
By Books and Furniture, Society's House, Hanover Square	2,000	0	0			
				22,468	1	9
By Account at Credit of Worcester Meeting				2,237	6	8
				£20,230	15	1

Examined, audited, and found correct, this 11th Day of August, 1863.

(Signed)

WILLIAM COPELAND ASTBURY.
HENRY CORBET.
WILLIAM COHEN.

Auditors on behalf
of the Society.

SHOW AT WORCESTER, JULY, 1863.

STEWARDS OF THE YARD.

Stewards of Stock.

THOMAS PAIN.
RICHARD MILWARD.
JOHN D. DENT, M.P.

Stewards of Implements.

SIR A. K. MACDONALD, BART.
WILLIAM TORR.
SIR E. KERRISON, BART., M.P.

Steward of Forage.

CHARLES S. CANTRELL.

Honorary Director of the Show.

B. T. BRANDRETH GIBBS.

JUDGES.

Stock.

Short-horns.

GEORGE DREWRY,
W. H. BEAUFORD,
JOHN UNTHANK.

Herefords.

E. L. FRANKLIN,
JOHN COLEMAN,
J. E. JONES.

Devons.

SAMUEL UMBERS,
R. B. WARREN,
H. W. KEARY.

Sussex and other Breeds.

SAMUEL BLOXSIDGE,
THOMAS HARRIS,
W. FISHER HOBBS.

Thorough-breeds and Hunters.

CHARLES BARNETT,
HENRY THURNALL,
HON. COLONEL COTTON.

Hackneys and Ponies.

J. EARLE WELBY,
J. E. BENNETT,
JOHN PARRINGTON.

Agriculturals, Drays, and Suffolks.

N. G. BARTHOLOPP,
T. BROOKS,
R. P. NISBET.

Leicesters.

F. JORDAN,
J. B. THOMPSON,
RICHARD WOODS.

Cotswolds and Lincolns.

HUGH AYLMER,
THOMAS GREETHAM,
H. BATEMAN.

Southdowns.

PETER PURVES,
HENRY OVERMAN,
HENRY FOOKE.

Shropshires and all others.

CHARLES RANDELL,
F. BUDD,
T. H. SAUNDERS.

Pigs.

J. S. TURNER.
J. MOON,
H. P. JONES.

Implements.

Steam-Cultivators.

H. B. CALDWELL,
CLARE SEWELL READ,
JACOB WILSON,
WILLIAM OWEN.

Steam-Engines.

J. V. GOOCH,
D. K. CLARKE,
J. STEWART.

Thrashing-Machines.

JOHN HICKEN,
WILLIAM CHALCRAFT,
GILSON MARTIN.

Dressing-Machines, &c., and Miscellaneous.

G. M. HIPWELL,
The REV. A. RIGG.

Veterinary-Inspectors.

PROFESSOR SIMONDS,
PROFESSOR VARNELL.
(Royal Veterinary College.)

Consulting-Engineer.

CHARLES EDWARDS AMOS.
(Firm of Easton and Amos.)

AWARD OF PRIZES.

NOTE.—The Judges were instructed to give in a *Reserved Number* to one animal in each Class, viz., the animal which would in their opinion possess sufficient merit for the Prize, in case an animal to which a Prize was awarded should subsequently become disqualified. If ten animals or pens were exhibited in any Class, a Silver Medal was awarded to the Third best.

CATTLE.

Short-horn Bulls.

JACOB WILSON, Manor House, Woodhorn, Morpeth, Northumberland: **FIRST PRIZE**, 25*l.*, for "Duke of Tyne" (17,751), roan, 4 years 7 months 3 weeks-old; bred by M. Spraggon, Nafferton, Stocksfield, Northumberland; sire, "Richard Cœur de Lion" (13,590); dam, "Welcome."

JOHN CHARLESWORTH, Headfield, Dewsbury, Yorkshire: **SECOND PRIZE**, 15*l.*, for "General Murat" (17,955), roan, 3 years 2 months 3 week-old; bred by himself; sire, "Prince Tallyrand" (16,765); dam, "Village Belle."

JOHN BRAWN, Shelfield, Walsall, Staffordshire: **THIRD PRIZE**, Silver Medal, for "Young Radford," roan, 3 years 1 month 3 weeks 3 days-old; bred by J. H. Bradburne, Pipe-place, Lichfield, Staffordshire; sire, "Sir Colin" (16,955); dam, "Miss Chance."

LORD FEVERSHAM, Duncombe Park, Helmsley, Yorkshire: the *Reserved Number*, to "Vice-Chancellor," red roan, 5 years 5 months 2 weeks 1 day-old; bred by himself; sire, "5th Duke of Oxford;" dam, "Varna."

VISCOUNT HILL, Hawkstone, Shrewsbury: **FIRST PRIZE**, 25*l.*, for "Hemlock," roan, 2 years, 4 months 3 weeks 3 days-old; bred by himself; sire, "Hetman" (14,702); dam, "Destiny."

JONATHAN PEEL, Knowlmere Manor, Clitheroe: **SECOND PRIZE**, 15*l.*, for "Hengist," white, 2 years 1 month 1 week 4 days-old; bred by himself; sire, "War Eagle" (15,483); dam, "Princess Maud."

COLONEL CHARLES TOWNELEY, Towneley Park, Burnley, Lancashire: **THIRD PRIZE**, Silver Medal, for "Royal Butterfly 10th" (18,761), red and white, 2 years 8 months 3 weeks 4 days-old; bred by himself; sire, "Royal Butterfly" (16,862); dam, "Parade."

SIR ANTHONY DE ROTHSCHILD, Bart., Aston Clinton, Tring, Buckinghamshire: the *Reserved Number*, to "Sheriff," red with white marks, 2 years 10 months 1 week 6 days-old; bred by himself; sire, "Lord Mayor" (14,828); dam, "Floret."

RICHARD EASTWOOD, Thorney Holme, Clitheroe, Lancashire: **FIRST PRIZE**, 25*l.*, for "The Hero," white, 1 year 1 month 3 weeks 1 day-old; bred by himself; sire, "Priam" (16,710); dam, "Heroine."

COLONEL CHARLES TOWNELEY, Towneley Park, Burnley, Lancashire: **SECOND PRIZE**, 15*l.*, for "Royal-Butterfly 11th," roan, 1 year 11 months 3 weeks

6 days-old; bred by himself; sire, "Royal Butterfly" (16,862); dam, "Pageant."

WILLIAM WOODWARD, Northway House, Ashchurch, Tewkesbury: **THIRD PRIZE**, Silver Medal, for "French Butterfly's Cœur de Lion," roan, 1 year 11 months 2 weeks 6 days-old; bred by Messrs. Atkinson, Bywell Hall Farm, Newcastle-on-Tyne; sire, "Richard Cœur de Lion" (13,590); dam, "Vestris's French Butterfly."

THE HON. COLONEL E. G. D. PENNANT, M.P., of Penrhyn Castle, Bangor Carnarvonshire: the *Reserved Number*, to "Earl of Darlington," roan, 1 year 5 months 4 weeks 2 days-old; bred by himself; sire, "Marmaduke" (14,897); dam, "Darlington the 8th."

SIR ANTHONY DE ROTHSCHILD, Bart., Aston Clinton, Tring, Bucks: **FIRST PRIZE**, 10*l.*, for "Captain Cherry," red and white, 10 months 1 day-old; bred by himself; sire, "Fortunatus;" dam, "Cherry Ripe."

GEORGE GARNE, Churchill Heath, Chipping Norton, Oxfordshire: **SECOND PRIZE**, 5*l.*, for "Pizarro," white, 10 months 1 week 5 days-old; bred by himself; sire, "Gondomar" (17,985); dam, "Patent."

JOSEPH ROBINSON, Clifton Pastures, Newport Pagnell, Bucks: **THIRD PRIZE**, Silver Medal, for "Pretor," rich roan, 7 months, 2 days-old; bred by himself; sire, "2nd Duke of Thorndale;" dam, "Prude."

SIR ANTHONY DE ROTHSCHILD, Bart., Aston Clinton, Tring, Bucks: the *Reserved Number*, to "Officer," roan, 10 months 2 weeks 5 days-old; bred by himself; sire, "Sheriff" (18,822); dam, "Samphire."

Short-Horn Cows and Heifers.

EMILY, LADY PIGOT, Branches Park, Newmarket, Cambridgeshire: **FIRST PRIZE**, 20*l.*, for "Pride of Southwicke," roan, 4 years 5 months 3 weeks 4 days-old, in-milk; bred by Mr. Stewart, Southwicke, Dumfries, Scotland; sire, "Mac Turk" (14,872); dam, "Vanity."

JOHN LANE, Barton Mills, Cirencester, Gloucestershire: **SECOND PRIZE**, 10*l.*, for "Maid of Athens," white, 3 years 4 months 1 week-old, in-milk and in-calf; bred by himself; sire, "Sir Richard (15,298); dam, "Miss Bloomer."

EARL SPENCER, Althorpe, Northampton: the *Reserved Number*, to "Veil," white, 5 years 3 weeks 2 days-old, in-calf; bred by himself; sire, "Vaulter" (15,451).

EMILY, LADY PIGOT, Branches Park, Newmarket, Cambridgeshire: **FIRST PRIZE**, 15*l.*, for "Rosedale," roan, 2 years 4 months 2 weeks 3 days-old, in-calf; bred by herself; sire, "Valasco" (15,443); dam, "Rosy."

RICHARD BOOTH, Warlaby, Northallerton, Yorkshire: **SECOND PRIZE**, 10*l.*, for "Queen of the May 2nd," roan, 2 years 5 months 3 weeks-old, in-calf; bred by himself; sire, "Windsor" (14,013) or "Sir Samuel" (15,302); dam, "Queen of the Vale."

COLONEL CHARLES TOWNELEY, Towneley Park, Burnley, Lancashire: **THIRD PRIZE**, Silver Medal, for "Roan Knight's Butterfly," red and white, 2 years 10 months 3 weeks 4 days-old, in-calf; bred by himself; sire, "Roan Knight" (15,067); dam, "Paris Butterfly."

COLONEL CHARLES TOWNELEY, Towneley Park, Burnley, Lancashire: the *Reserved Number*, to "Royal Butterfly's Duchess," roan, 2 years 4 months-old, in-calf; bred by himself; sire, "Royal Butterfly" (16,862); dam, "Roan Duchess 2nd."

THE DUKE OF MONTROSE, Buchanan Castle, Glasgow: **FIRST PRIZE**, 15*l.*, for

"Flower Girl," red roan, 1 year 11 months 3 weeks 4 days-old; bred by himself; sire, "Baron Killerby;" dam, "Flora."

COLONEL CHARLES TOWNELEY, Towneley Park, Burnley, Lancashire: **SECOND PRIZE**, 10*l.*, for "Frederick's Farewell," roan, 1 year 8 months 3 weeks 1 day-old; bred by himself; sire, "Frederick" (11,489); dam, "Vestris 3rd."

EMILY, LADY PIGOT, Branches Park, Newmarket, Cambridgeshire: **THIRD PRIZE**, Silver Medal, for "Castianira," roan, 1 year 10 months 1 day-old; bred by herself; sire, "Lord of the Valley" (14,837); dam, "Castanet."

COLONEL CHARLES TOWNELEY, Towneley Park, Burnley, Lancashire: the *Reserved Number*, to "Bampton Butterfly," roan, 1 year 7 months 3 weeks 3 days-old; bred by himself; sire, "Royal Butterfly" (16,862); dam, "Young Bampton Rose."

DAVID M'INTOSH, Havering Park, Romford, Essex: **FIRST PRIZE**, 10*l.*, for "Lady Oxford 5th," roan, 11 months 2 days-old; bred by himself; sire, "Third Duke of Thorndale" (17,749); dam, "Lady Oxford 4th."

ROBERT E. OLIVER, Sholebroke Lodge, Towcester, Northamptonshire: **SECOND PRIZE**, 5*l.*, for "Lalage the Second," red, 11 months 2 weeks 5 days-old; bred by himself; sire, "Romulus Butterfly" (18,741); dam, "Lalage."

COLONEL CHARLES TOWNELEY, Towneley Park, Burnley, Lancashire: **THIRD PRIZE**, Silver Medal, for "Royal Butterfly's Pageant," red and white, 10 months 3 weeks 4 days-old; bred by himself; sire, "Royal Butterfly" (16,862); dam, "Pageant."

JOSEPH HEGAN, Dawpool, Neston, Chester: the *Reserved Number*, to "Grand Duchess 12th," roan, 11 months 3 weeks 2 days-old; bred by himself; sire, "Imperial Oxford" (18,084); dam, "Grand Duchess 9th."

Hereford Bulls.

JOHN HUNGERFORD ARKWRIGHT, Hampton Court, Leominster, Herefordshire: **FIRST PRIZE**, 25*l.*, for "Sir Oliver the Second," red with white face, 4 years 8 months 1 week 4 days-old; bred by T. Rea, Westonbury, Leominster; sire, "Sir Benjamin;" dam, "Eva."

THOMAS DAVIES, Lady Meadow, Leominster, Herefordshire: **SECOND PRIZE**, 15*l.*, for "Plato" (2160), red with white face and mane, 4 years 3 months 3 weeks 2 days-old; bred by T. Rea, Westonbury, Pembridge, Leominster; sire, "Sir Benjamin" (1387); dam, "Isabella."

LORD BATEMAN, Shobden Court, Shobden, Herefordshire: the *Reserved Number*, to "Golden Horn," red with white face, 4 years 11 months 1 week 4 days-old; bred by W. Perry, Cholstrey, Leominster, Herefordshire; sire, "Monkland;" dam, "Bury the 3rd."

WILLIAM TAYLOR, Showle Court, Ledbury, Herefordshire: **FIRST PRIZE**, 25*l.*, for "Tambarine" (2254), red with white face, 2 years 10 months 2 weeks 1 day-old; bred by Lord Bateman, Shobdon, Herefordshire; sire, "Carlisle" (923); dam, "Little Beauty."

WILLIAM COOKE MORRIS, Whitwick, Ledbury, Herefordshire: **SECOND PRIZE**, 15*l.*, for "Moderator," red with white face, 2 years 10 months-old; bred by Lord Bateman, Shobdon, Herefordshire; sire, "Carlisle;" dam, "Lily."

HENRY RAWLINGS EVANS, jun., Swanston Court, Dilwyn, Leominster, Herefordshire: **THIRD PRIZE**, Silver Medal, for "Rodney," red with white face, 2 years 11 months 2 weeks 4 days-old; bred by himself; sire, "Chadnor" (1531); dam, "Young Lovely."

- JOHN ALBERT HOLLINGS, How Caple, Ross, Herefordshire: the *Reserved Number*, to "Chieftain the Second" (1917), red with white face, 2 years 11 months 3 weeks-old; bred by the late James Rea, Monaghtry, Knighton; sire, "Wellington" (1112); dam, "Gertrude."
- THOMAS EDWARDS, Wintercot, Leominster, Herefordshire: **FIRST PRIZE**, 25*l.*, for "Adforton" (1839), red with white face, 1 year 10 months 1 week 3 days-old; bred by W. Tudge, Adforton, Leintwardine, Salop; sire, "The Grove" (1764); dam, "Dainty."
- JOHN BALDWIN, Luddington, Stratford-on-Avon, Warwickshire: **SECOND PRIZE**, 15*l.*, for "Battersea," red and white, 1 year 11 months 2 weeks-old; bred by Charles Vevers, Ivington Park, Leominster; sire, "Corn Exchange;" dam, "Pigeon."
- EDWARD TANNER, jun., Hopton Castle, Aston-on-Clun, Salop: **THIRD PRIZE**, Silver Medal, for "Ballarat" (1957), red with white face, 1 year 8 months-old; bred by himself; sire, Buckton (1891); dam, "Ruby."
- GEORGE PITT, Chadnor Court, Dilwyn, Leominster, Herefordshire: the *Reserved Number*, to "San Jacinto," red with white face, 1 year 10 months 1 week 3 days-old; bred by himself; sire, "Hatfield;" dam, "Duchess."
- THOMAS ROBERTS, Ivington Bury, Leominster, Herefordshire: **FIRST PRIZE**, 10*l.*, for his red with white face, 11 months 4 days-old; bred by himself; sire, "Sir Thomas" (2228); dam, "Duchess."
- R. HARCOURT CAPPER, The Northgate, St. Weonard's, Ross, Herefordshire: **SECOND PRIZE**, 5*l.*, for "Worcester," red with white face, 10 months 2 weeks-old; bred by himself; sire, "Lord Wellington" (2094); dam, "Ada."
- EDMUND WRIGHT, Halston Hall, Oswestry, Salop: **THIRD PRIZE**, Silver Medal, for "David," red with white face, 11 months 2 weeks 2 days-old; bred by himself; sire, "Magnet 2nd" (989); dam, "We-we."
- EDMUND WRIGHT, Halston Hall, Oswestry, Salop: the *Reserved Number*, to "Lion," red with white face, 11 months 3 weeks 4 days-old; bred by himself; sire, "Magnet 2nd" (989); dam, "Lioness."

Hereford Cows and Heifers.

- WILLIAM PERRY, St. Oswald, Cholstrey, Leominster, Herefordshire: **FIRST PRIZE**, 20*l.*, for "Beauty," red and white, 3 years 11 months 3 weeks-old, in-calf; bred by himself; sire, "Noble Boy" (1337); dam, "Bury 3rd."
- THOMAS REA, Westonbury, Pembridge, Herefordshire: **SECOND PRIZE**, 10*l.*, for "Kate the Second," red with white face and mane, 4 years 8 months 4 weeks old, in-calf; bred by himself; sire, "Sir Benjamin;" dam, "Kate."
- THOMAS DUCKHAM, Baysham Court, Ross, Herefordshire: **THIRD PRIZE**, Silver Medal, for "Delight," red with white face, 8 years 6 months-old, in-milk and in-calf; bred by himself; sire, "Pope" (527); dam, "Eywood."
- PHILIP TURNER, The Leen, Pembridge, Herefordshire: the *Reserved Number*, to "Ursula," red with white face, 6 years 2 months 1 week-old, in-milk and in-calf; bred by himself; sire, "Sir David" (349); dam, "Gaudy."
- WILLIAM TUDGE, Adforton, Leintwardine, Herefordshire: **FIRST PRIZE**, 15*l.*, for "Lady Ashford," red with white face, 2 years 6 months 5 days-old, in-calf; bred by himself; sire, "Carbonel" (1525); dam, "Lady."
- GEORGE PITT, Chadnor Court, Dilwyn, Leominster, Herefordshire: **SECOND PRIZE**, 10*l.*, for his red with white face, 2 years 6 months 2 weeks

2 days-old, in-calf; bred by himself; sire, "Luck's Ace;" dam, "Handsome."

MAJOR-GENERAL THE HON. A. NELSON HOOD, Cumberland Lodge, Windsor, Berks: the *Reserved Number*, to "Adela," red with white face, 2 years 6 months 2 weeks 5 days-old, in-milk; bred by the late Lord Berwick; sire, "Will-o'-the-Wisp" (1454); dam, "Agnes."

JOHN MONKHOUSE, The Stow, Hereford: **FIRST PRIZE**, 15*l.*, for "Clementine," red with white face, 1 year 11 months 3 weeks 3 days-old; bred by himself; sire, "Chieftain;" dam, "Columbine."

THOMAS ROBERTS, Irvington Bury, Leominster, Herefordshire: **SECOND PRIZE**, 10*l.*, for "Duchess of Bedford 2nd," red with white face, 1 year 9 months 1 week-old; bred by himself; sire, "Sir Thomas" (2228); dam, "Duchess of Bedford."

WILLIAM PERRY, St. Oswald, Cholstrey, Leominster, Herefordshire: **THIRD PRIZE**, Silver Medal, for "Lady Duppa," red with white face, 1 year 5 months 3 weeks 3 days-old; bred by himself; sire, "Lord Wellington" (2094); dam, "Flower of Worcester."

THE HON. THOMAS HENRY NOEL HILL, Berrington, Shrewsbury: the *Reserved Number*, for "Petunia," red with white face, 1 year 9 months 2 weeks-old; bred by the late Lord Berwick; sire, "Will-o'-the-Wisp" (1454); dam, "Polyanthus."

THOMAS ROBERTS, Irvington Bury, Leominster, Herefordshire: **FIRST PRIZE**, 10*l.*, for "Miss Hastings Second," red with white face, 11 months 2 weeks 4 days-old; bred by himself; sire, "Sir Thomas" (2228); dam, "Lady Hastings."

A. J. ROUSE BOUGHTON KNIGHT, Downton Castle, Ludlow, Herefordshire: **SECOND PRIZE**, 5*l.*, for "Lady Jane Grey," grey, 7 months 3 weeks 2 days-old; bred by himself; sire, "Lord Grey" (2085); dam, "Snowdrop."

WILLIAM PERRY, St. Oswald, Leominster, Herefordshire: the *Reserved Number*, to "Young Lady Wellington," red and white, 11 months 2 weeks 4 days-old; bred by himself; sire, "Lord Wellington;" dam, "Princely."

Devon Bulls.

SAMUEL P. NEWBERRY, Scrul Barton, Honiton, Devon: **FIRST PRIZE**, 25*l.*, for "Prince Jerome," red, 3 years 2 days-old; bred by John Mildon, Witheridge, Tiverton, Devon; sire, "Quartly's Napoleon" (259); dam, "Beauty."

WALTER FARTHING, Stowey Court, Bridgwater, Somerset: **SECOND PRIZE**, 15*l.*, for "Viscount," red, 3 years 7 months 2 weeks-old; bred by himself; sire, "Sir Peregrine;" dam, "Molly."

WILLIAM TREFFRY, Penhesken, Grampound, Cornwall: the *Reserved Number*, to "Sir Colin" (723), red, 4 years 3 months 2 weeks-old; bred by himself; sire, "Viscount" (544); dam, "Red Rose" (1604).

J. S. SURMAN, Swindon Hall, Cheltenham, Gloucestershire: **FIRST PRIZE**, 25*l.*, for "Van Tromp," red, 2 years 9 months 1 week-old; bred by George Turner, Beacon Downes, Exeter; sire, "Prince Frederick;" dam, "Vaudine."

JAMES MERSON, Brinsworthy, North Molton, Devon: **SECOND PRIZE**, 15*l.*, for "Fusileer," red, 2 years 7 months 2 weeks 4 days-old; bred by W. Hole, Hannaford, Barnstaple; sire, "Comet;" dam, "Laura" (256).

MAJOR-GENERAL THE HON. A. NELSON HOOD, Cumberland Lodge, Windsor: **FIRST PRIZE**, 25*l.*, for "Prince Alfred," red, 1 year 10 months 4 weeks-

old; bred by H.R.H. The Prince Consort; sire, "Colonel" (387); dam, "Fancy" (703).

JOHN AZARIAH SMITH, Bradford Peverell, Dorchester, Dorset: **SECOND PRIZE**, 15*l.*, for "Constitution," red, 1 year 3 months 3 weeks 1 day-old; bred by himself; sire, "Exchange" (627); dam, "Rachael."

CHARLES FREDERICK PERKINS, The Grange, Kingston, Taunton, Somersetshire: the *Reserved Number*, to "Corporal," red, 1 year 2 months 3 days-old; bred by Walter Farthing, Stowey Court, Bridgwater, Somerset; sire, "Champion;" dam, "Cheerful."

GEORGE TURNER, Beacon Downes, Exeter, Devon: **FIRST PRIZE**, 10*l.*, for "The Drone," red, 8 months 4 weeks 1 day-old; bred by himself; sire, "The Little Known;" dam, "Beeswing."

WALTER FARTHING, Stowey Court, Bridgwater, Somerset: **SECOND PRIZE**, 5*l.*, for his red, 6 months 1 day-old; bred by himself; sire, "Sir Peregrine;" dam, "Molly."

JAMES WENTWORTH BULLER, M.P., Downes, Crediton, Devon: the *Reserved Number*, to his red, 10 months 2 weeks-old; bred by himself.

Devon Cows and Heifers.

JOHN AZARIAH SMITH, Bradford Peverell, Dorchester, Dorset: **FIRST PRIZE**, 20*l.*, for "Rachel," red, 4 years 7 months 4 days-old, in-milk; bred by Lord Portman, Bryanston House, Blandford, Dorset; sire, "Palmerston" (476); dam, "Rachel."

WALTER FARTHING, Stowey Court, Bridgwater, Somerset: **SECOND PRIZE**, 10*l.*, for "Cheerful," red, 7 years 1 month 1 week-old, in-milk; bred by Mr. Morrish, Stobrook, Crediton, Devon.

MAJOR-GENERAL THE HON. A. NELSON HOOD, Cumberland Lodge, Windsor, the *Reserved Number*, to "Hyacinth," red, 5 years 10 months 6 days-old, in-calf; bred by H.R.H. The Prince Consort; sire, "Zouave" (556); dam, "Crocus" (1238).

CHARLES HAMBRÖ, Milton Abbey, Blandford, Dorset: **FIRST PRIZE**, 15*l.*, for "Lina," red, 2 years 10 months 3 weeks 3 days-old, in-calf; bred by himself; sire, "Sir Colin;" dam, "Young Daisy."

WALTER FARTHING, Stowey Court, Bridgwater, Somerset: **SECOND PRIZE**, 10*l.*, for "Jenny," red, 2 years 5 months 2 weeks-old, in-calf; bred by himself; sire, "Sir Peregrine;" dam, "Lovely."

CHARLES FREDERICK PERKINS, The Grange, Kingston, Taunton, Somerset: the *Reserved Number*, to "Alice," red, 2 years 4 months 2 weeks 2 days-old, in-calf; bred by Walter Farthing, Stowey Court, Bridgwater; sire, "Sir Peregrine;" dam, "Flora" (1346).

JAMES WENTWORTH BULLER, M.P., Downes, Crediton, Devon: **FIRST PRIZE**, 15*l.*, for his red, 1 year 9 months 3 weeks 2 days-old; bred by himself.

GEORGE TURNER, Beacon Downes, Exeter, Devon: **SECOND PRIZE**, 10*l.*, for "Devoniensis," red, 1 year 3 months-old; bred by himself; sire, "The Little Known;" dam, "Maydew."

EDWARD POPE, Great Toller, Maiden Newton, Dorset: the *Reserved Number*, to "Fancy 6th," red, 1 year 8 months-old; bred by himself; sire, "Goldfinder;" dam, "Fancy 4th."

MAJOR-GENERAL THE HON. A. NELSON HOOD, Cumberland Lodge, Windsor: **FIRST PRIZE**, 10*l.*, for "Rose of Denmark," red, 11 months-old; bred by himself, at H.R.H. the Prince Consort's Norfolk Farm, Windsor; sire, "Colonel" (387); dam, "Fancy" (703).

GEORGE TURNER, Beacon Downes, Exeter, Devon: SECOND PRIZE, 5*l.*, for "Lady Audley," red, 10 months-old; bred by himself; sire, "The Little Known;" dam, "Fanny Fern."

MAJOR-GENERAL THE HON. A. NELSON HOOD, Cumberland Lodge, Windsor: the *Reserved Number*, to "Princess Helena," red, 9 months 1 week 1 day-old; bred by himself, at H.R.H. the Prince Consort's Norfolk Farm, Windsor; sire, "Saracen" (520A); dam, "Sweetbriar" (1665).

Sussex Bulls.

WILLIAM MARSHALL, Bolney Place, Cuckfield, Sussex: FIRST PRIZE, 10*l.*, for "Prince Alfred," red, 3 years 6 months-old; bred by W. Jollands, Buxshall, Lindfield, Sussex; dam, "Waxey."

JOHN and ALFRED HEASMAN, Angmering, Arundel, Sussex: SECOND PRIZE, 5*l.*, for "Viscount" (77), red, 3 years 3 months 1 week-old; bred by themselves; sire, "Marquis" (16); dam, "Countess" (30).

EDWARD CANE, Berwick Court, Lewes, Sussex: the *Reserved Number*, to "Prince," red, 4 years 6 months-old; bred by Josiah Pitcher, Hailsham, Hurst Green, Sussex.

JOHN and ALFRED HEASMAN, Angmering, Arundel, Sussex: FIRST PRIZE, 10*l.*, for "First Fruit," red, 1 year 5 months 1 week 3 days-old; bred by themselves; sire, "Viscount" (77); dam, "Maid of Ham" (590).

Sussex Cows and Heifers.

TILDEN SMITH, Knell, Beckley, Staplehurst, Sussex: FIRST PRIZE, 10*l.*, for "Canterbury," red, 5 years 2 months 2 weeks-old, in-milk and in-calf; bred by himself; sire, "Gorringe;" dam, "Butler."

JOHN and ALFRED HEASMAN, Angmering, Arundel, Sussex: SECOND PRIZE, 5*l.*, for "Lily" (684), red, 3 years 6 months 2 weeks-old, in-milk and in-calf; bred by themselves; sire, "Marquis" (16); dam, "Snow-drop" (265).

EDWARD CANE, Berwick Court, Lewes, Sussex: the *Reserved Number*, to "Simla," red, 7 years 5 months-old, in-calf; bred by T. Child, Southover, Lewes, Sussex.

JOHN and ALFRED HEASMAN, Angmering, Arundel, Sussex: FIRST PRIZE, 10*l.*, for "Battersea" (789), red, 2 years 6 months-old, in-calf; bred by themselves; sire, "Marquis" (16); dam, "Hopeful" (180).

JOHN and ALFRED HEASMAN, Angmering, Arundel, Sussex: FIRST PRIZE, 10*l.*, for "Preceptress," red, 1 year 5 months 2 weeks 3 days-old; bred by themselves; sire, "Marquis" (16); dam, "Governess" (135).

GEORGE JENNER, Parsonage House, Udimore, Rye, Sussex: SECOND PRIZE, 5*l.*, for "Twin Mayflower No. 1," red, 1 year 3 months 2 weeks 1 day-old; bred by himself; sire, "Challenger" (33); dam, "Mayflower" (74).

Bulls of other Established Breeds.

JAMES DAVIS, Melcombe Horsey, Dorchester, Dorset: FIRST PRIZE, 10*l.*, for "Melcombe" white and grey, 2 years 2 months 3 weeks-old (long horn); bred by J. H. Burbery, the Chase Farm, Kenilworth, Warwickshire.

THE HON. COLONEL E. G. D. PENNANT, M.P., Penrhyn Castle, Bangor, Carnarvonshire: SECOND PRIZE, 5*l.*, for his black, 3 years 4 months 1 day-old (Welsh); bred by Richard Williams, Bodafon, Llanerchymedd, Anglesey.

JAMES DUMBRILL, Ditchling, Hurstperpoint, Sussex: **THIRD PRIZE**, Silver Medal, for "St. Helier," grey, about 2 years 2 months-old (Channel Islands); breeder unknown.

SIR EDWARD KERRISON, Bart., M.P., Brome Hall, Scole, Suffolk: the *Reserved Number*, to "Rifleman," blood red, 4 years 10 months 4 days-old (Suffolk); bred by Arthur Crisp, Chillesford, Wickham Market, Suffolk; sire, "Yeoman;" dam, "Red Rose."

SIR WILLOUGHBY JONES, Bart., M.P., Cranmer Hall, Fakenham, Norfolk: **FIRST PRIZE**, 10*l.*, for "Rufus," dark red, 1 year 4 months 1 week 1 day-old (Norfolk Polled); bred by himself.

HENRY LE FEUVRE, Les Nièmes, St. Peter's, Jersey: **SECOND PRIZE**, 5*l.*, for "Hero," grey and white, 1 year 5 months 1 week 4 days-old; bred by himself; sire, "Butterfly;" dam, "Cowslip."

ELDRID BECK, Grand Quivilette, St. Martin's, Guernsey: the *Reserved Number*, to "Albert II.," yellow and white, 1 year 8 months-old (Guernsey); bred by himself; sire, "Albert I.;" dam, "Fancy."

Cows and Heifers of other Established Breeds.

SIR EDWARD KERRISON, Bart., M.P., Brome Hall, Scole, Suffolk: **FIRST PRIZE**, 10*l.*, for "Duchess of Suffolk," red, 9 years-old (Suffolk Polled), in-milk and in-calf; breeder not known.

SIR WILLOUGHBY JONES, Bart., M.P., Cranmer Hall, Fakenham, Norfolk: **SECOND PRIZE**, 5*l.*, for "Hetty," red, 4 years 6 months 2 weeks 3 days-old (Norfolk Polled), in-milk and in-calf; bred by Lord Sondes, Elmham Hall, Thetford, Norfolk.

LORD SONDES, Elmham Hall, Thetford, Norfolk: **THIRD PRIZE**, Silver Medal, for "Crocus," red, 6 years 1 month-old (Norfolk Polled), in-milk and in-calf; bred by himself.

LORD SONDES, Elmham Hall, Thetford, Norfolk: the *Reserved Number*, to "Daisy," red, 4 years 3 months-old (Norfolk Polled), in-milk and in-calf; bred by himself.

SIR EDWARD KERRISON, Bart., M.P., Brome Hall, Scole, Suffolk: **FIRST PRIZE**, 10*l.*, for "Isabella," blood red, 2 years 10 months 3 weeks 5 days-old (Polled Suffolk), in-calf; bred by himself.

LORD SONDES, Elmham Hall, Thetford, Norfolk: **SECOND PRIZE**, 5*l.*, for "Rosette," red, 2 years 4 months-old (Norfolk Polled), in-calf; bred by himself.

ALBERT LE GALLAIS, La Moie House, St. Aubin's, Jersey: **THIRD PRIZE**, Silver Medal, for "Daisy," grey and white, 2 years 3 months-old (Jersey, commonly called Alderney), in-calf; breeder unknown.

SIR EDWARD KERRISON, Bart., M.P., Brome Hall, Scole, Suffolk: the *Reserved Number* to "Arabella," red, with white spots, 2 years 2 months 3 weeks 1 day-old (Suffolk Polled), in-calf; bred by H. M. Day, Langham, Suffolk; sire, "Lord Nelson."

LORD SONDES, Elmham Hall, Thetford, Norfolk: **FIRST PRIZE**, 10*l.*, for "Cherry," dark red, 1 year 7 months-old (Norfolk Polled); bred by himself.

LORD SONDES, Elmham Hall, Thetford, Norfolk: **SECOND PRIZE**, 5*l.*, for "Pink," red, 1 year 6 months-old (Norfolk Polled); bred by himself.

SIR WILLOUGHBY JONES, Bart., M.P., Cranmer Hall, Fakenham, Norfolk: **THIRD PRIZE**, Silver Medal, for his dark red, 1 year 5 months 1 week 6 days-old (Norfolk Polled); bred by himself.

SIR EDWARD KERRISON, Bart., M.P., Brome Hall, Scole, Suffolk: the *Reserved Number*, to "Plover the 3rd," blood red, 1 year 10 months 3 weeks 1 day-old (Suffolk); bred by himself; sire, "Young Oakley;" dam "Plover."

HORSES.

Thorough-bred Stud Horses.

WILLIAM GULLIVER, Swadcliffe, Banbury, Oxfordshire: **FIRST PRIZE**, 100*l.*, for "Neville," bay, 12 years-old; bred by Mr. Singleton; sire, "Napier by Gladiator;" dam, "Sally Snobs."

EDWARD GEORGE SIMPSON, Levent Bridge, Yarm, Yorkshire: **SECOND PRIZE**, 25*l.*, for "Cavendish," brown, 7 years-old; bred by William Robinson, Richmond, Yorkshire; sire, "Vultigeur;" dam, "Countess of Burlington."

HENRY RICHARD PHILLIPS, Willesden Paddocks, Kilburn, Middlesex: **THIRD PRIZE**, Silver Medal, for "Cambondo," chesnut, 6 years-old; bred by Sir George Strickland, Bart., Boynton Hall, Bridlington, Yorkshire; sire, "Orpheus;" dam, "Camellia."

JOHN WILLIAM MILES, King's Weston, Bristol, Gloucestershire: the *Reserved Number*, to "Rouble," bay, 7 years-old; bred by J. Cookson, Neasham Hall, Darlington, Durham; sire, "Cossack;" dam, "Dividend."

Hunter Stallions.

WILLIAM BARNETT, Bay's Hill Lawn, Cheltenham, Gloucestershire: **FIRST PRIZE**, 25*l.*, for "Sir Peter Laurie," brown, 19 years-old; bred by the late Hon. R. Watson, Rockingham Castle, Market Harboro', Leicestershire; sire, "The Saddler;" dam, "Well-a-day."

JOHN BATTY, Mains Farm, Ripon, Yorkshire: **SECOND PRIZE**, 15*l.*, for "Elcott," bay, 12 years-old; bred by Mr. Clark, Marlborough, Wilts; sire, "Venison;" dam, "Defend."

WILLIAM WATSON, The Beauchorns, Cheltenham, Gloucestershire: **THIRD PRIZE**, Silver Medal, for "Safeguard," chesnut, about 12 years-old; bred by Mr. Ferrier, Huntingdon Farm, Kingston, Hereford; sire, "Safeguard."

GEORGE MANDEB ALLENDER, Lee Grange, Winslow, Bucks: the *Reserved Number*, to "Bromley," chesnut, 3 years-old; bred by W. S. Shuttleworth, Bromley, Kent; sire, "Marsyas;" dam, "Deception."

Hunter Mares and Foals.

JOHN WATSON, Waresley, Kidderminster, Worcestershire: **FIRST PRIZE**, 15*l.*, for "Lalage," bay, with black legs, 14 years-old (with foal at foot); bred by Mr. Holmes; sire, "Epirus;" dam, "Mulligatawny."

EDWARD NICHOLAS HYGATE, Buckland, Leominster, Herefordshire: **SECOND PRIZE**, 10*l.*, for "Whisky," dark brown, 10 years-old (with foal at foot); breeder unknown; sire, "Windhound."

ANDREW ROUSE BOUGHTON KNIGHT, Downton Castle, Ludlow, Herefordshire: **THIRD PRIZE**, Silver Medal, for "Salt Fish," dark brown, 14 years-old (with foal at foot); breeder unknown; sire, "Leander."

JAMES GREGG, Fencote, Docklow, Leominster, Herefordshire : the *Reserved Number*, to "The Madley," chesnut, about 11 years-old (with foal at foot); bred by the late John Walker, Madley, Hereford; sire, "Safe-guard."

Hackney Mares and Foals.

HUGH PERCY, Eskrigg, Wigton, Cumberland : FIRST PRIZE, 15*l.*, for "Crafty," brown, 5 years-old; bred by Mrs. A. Dalziel, Stamburn Hall, Workington, Cumberland; sire, "The Judge;" dam, "Old Crafty."

SAMUEL WALKER URWICK, Leinthall, Ludlow, Herefordshire : SECOND PRIZE, 10*l.*, for "Polly," bay, 14 years-old (with foal at foot); bred by Mrs. Roberts, Trippleton, Leintwardine, Herefordshire; sire, "The Steamer."

GEORGE M'KENZIE KETTLE, Dallicott House, Bridgnorth, Salop: the *Reserved Number*, to "Cygnet," bay, aged (with foal at foot); breeder unknown.

Pony Stallions.

JAMES MOFFIT, Kirklington Park, Carlisle, Cumberland : FIRST PRIZE, 15*l.*, for "Tom Sayers," dark brown, 6 years 4 months-old; bred by Mr. Helme, Caldbeck, Carlisle, Cumberland; sire, "Highland Laddie."

SILVANUS EDWARDS, Middleton Priors, Bridgnorth, Salop : SECOND PRIZE, 5*l.*, for "Dick," brown, 9 years 2 months-old; bred by himself; sire, "Matchless by Muley;" dam, "Jenny."

WILLIAM NORMAN, Aspatia, Carlisle, Cumberland : the *Reserved Number*, to "Jack," chesnut, 3 years 3 weeks 2 days-old; bred by himself; sire, "Potentate;" dam, "Jessie."

Pony Mares.

FREDERICK BRANWHITE, Chapel House, Long Melford, Sudbury, Suffolk : FIRST PRIZE, 10*l.*, for "Pretty Lass," roan, 7 years-old; bred by Mrs. Coe, Long Melford, Sudbury, Suffolk; sire, "Phenomenon;" dam, "Beauty."

THOMAS FULCHER, Elmham, Thetford, Norfolk : SECOND PRIZE, 5*l.*, for "Enid," black, 4 years-old; bred by Paul Bell, Stiffkey, Wells, Norfolk; sire, "Robin Hood."

JOHN KNIGHT, Marlborough House, Newbury, Berkshire : THIRD PRIZE, Silver Medal, for his dark chesnut, 5 years old; bred by himself.

FREDERICK BRANWHITE, Chapel House, Long Melford, Sudbury, Suffolk : the *Reserved Number*, to "Princess," bay, 6 years-old; bred by Mr. Bear, Acton, Sudbury, Suffolk; sire, "Brier;" dam, "Polly."

Agricultural Stallions (not Suffolks).

JOSEPH YEOMANS, Pennymore Hay, Shareshill, Staffordshire : FIRST PRIZE, 25*l.*, for "Black Prince," black, 8 years-old; bred by Mr. Wheeler, Eveaham, Worcestershire; sire, "Merryman."

WILLIAM RAINE, Morton Timmouth, Darlington, County Durham : SECOND PRIZE, 10*l.*, for "Young Clyde," bay, 5 years 1 month 2 weeks-old; bred by Thomas Marshall, of Howes, Annan, Dumfriesshire.

THE DUKE OF MARLBOROUGH, Blenheim Palace, Woodstock, Oxford : THIRD PRIZE, Silver Medal, for "Culloden," brown, 5 years 1 week-old (Clydesdale); bred by himself; sire, "Glengary;" dam, "Blossom."

JAMES ORAM, Shellingford, Faringdon, Berks: the *Reserved Number*, to "Young Champion," chesnut, 3 years 3 weeks 5 days-old; bred by himself; sire, "Bishopstone;" dam, "Diamond."

Award of Live-Stock Prizes at Worcester.

- WILLIAM CONEY**, Battenhall, Worcester: **FIRST PRIZE**, 20*l.*, for his chestnut, 2 years 1 month 1 week 2 days-old; bred by himself; sire, "Duke of Wellington;" dam, "Whitefoot."
- WILLIAM CONEY**: **SECOND PRIZE**, 10*l.*, for his bay, 2 years 2 months 1 week 6 days-old; bred by himself; sire, "Duke of Wellington;" dam, "White Flower."
- EDWARD HOLLAND**, M.P., Dumbleton Hall, Evesham, Gloucestershire: **THIRD PRIZE**, Silver Medal, for his bay, 2 years 2 months 3 weeks-old; bred by himself; sire, "Noble;" dam, "Scott."
- THOMAS MILLS**, Harmston, Lincoln: the *Reserved Number*, to his "Young Lincoln," black, 2 years 4 months-old; bred by J. Jackson, Flawborough, Newark, Notts; sire, "Young Champion;" dam, "Bonny."

Agricultural Mares and Foals (not Suffolks).

- ELIZABETH BULL**, Weobley, Hereford: **FIRST PRIZE**, 20*l.*, for "Jolly," grey, 8 years-old; bred by the late Samuel Bull, Weobley.
- JAMES CORBETT**, Coventry Arms, Croome, Kempsey, Worcestershire: **SECOND PRIZE**, 10*l.*, for his roan, 4 years 1 month 2 weeks-old; bred by himself.
- EDMUND HERBERT**, Powick, Worcester: **THIRD PRIZE**, Silver Medal, for his grey, 8 years-old; bred by himself.
- JOHN BELL**, Ryme North, Sleaford, Lincolnshire: the *Reserved Number*, to "Gipsy," black, 8 years-old; bred by William Green, Dorrington, Sleaford.

Agricultural Fillies (not Suffolks).

- CHARLES PRIDAY**, Longford, Gloucester: **FIRST PRIZE**, 15*l.*, for "Flower," chestnut, 2 years 1 month-old; bred by himself; sire, "Noble;" dam, "Flower."
- HON. COLONEL E. G. D. PENNANT**, M.P., Penrhyn Castle, Bangor, Caernarvonshire: **SECOND PRIZE**, 10*l.*, for his grey, 2 years 3 weeks 5 days-old; bred by himself; sire, "Matchless;" dam, "Flower."
- ISAAC MANN**, Frampton, Winchcombe, Gloucestershire: the *Reserved Number*, to "Darling," red roan, 2 years 1 month 3 weeks 4 days-old; bred by himself; sire, "Noble;" dam, "Smiler."

Dray Stallions.

- THOMAS JOHNSON**, Hatfield, Doncaster, Yorkshire: **FIRST PRIZE**, 25*l.*, for "Young John Bull," grey, 8 years-old; bred by W. Wynder, Sand Bramwith, Doncaster; sire, "Warwick."
- WILLIAM HENRY NEALE**, Old Eclipse Inn, Mansfield, Notts: **SECOND PRIZE**, 10*l.*, for "Prince of London," black roan, 3 years-old; bred by himself; sire, "Waterloo;" dam, "Bonnie."
- PETER LEATHER**, Stretton, Warrington, Cheshire: the *Reserved Number*, to "Prince William," brown, 6 years-old; breeder unknown; sire, "Coburg."
- CHARLES MORRISON**, Basildin Park, Reading, Berks: **FIRST PRIZE**, 20*l.*, for "Basildin," roan, 2 years 1 month 2 weeks 3 days-old; bred by himself; dam, "Smiler."
- JAMES ABELL**, Leopard Grange, Worcester: **SECOND PRIZE**, 10*l.*, for "Crichton," dark brown, 2 years 1 month 1 week-old; bred by himself; sire, "King of the Valley;" dam, "Pert."

EDWARD SUMPTER, Billingham Dales, Sleaford, Lincolnshire; the *Reserved Number* to "Champion," dark brown, 2 years 3 months-old; bred by himself; sire, "England's Glory;" dam, "Trip."

Dray Mares and Foals.

GEORGE HASSELL, Barton Hill, Bristol, Gloucestershire: **FIRST PRIZE, 20*l.***, for "Black Bess," black, aged; breeder unknown.

Suffolk Stallions.

WALTER GARRETT ROOFE, East Stockwell, Street, Colchester, Essex: **FIRST PRIZE, 20*l.***, for "Duke," chesnut, 8 years-old; bred by the late S. Wrinch, Great Holland, Colchester, Essex; sire, "Catlin's Duke."

MORRIS MUMFORD, Creeting St. Peter, Needham Market, Suffolk: **FIRST PRIZE, 15*l.***, for "Young Duke," chesnut, 2 years-old; bred by the late W. Crosse; sire, "Royal Duke;" dam, "Diamond."

ISAAC RIST, Tattingstone, Ipswich, Suffolk: **SECOND PRIZE, 10*l.***, for "Young Emperor," chesnut, 2 years 2 months 3 weeks 6 days-old; bred by himself; sire, "Chester Emperor;" dam, "Scott."

WILLIAM WILSON, Baylham Hall, Ipswich, Suffolk: the *Reserved Number*, to his chesnut, 2 years 3 months-old; bred by S. Plowman, Earls Stonham, Suffolk; sire, "Duke."

Suffolk Mares and Foals.

SIR EDWARD KERRISON, Bart., M.P., Broune Hall, Soale, Suffolk: **FIRST PRIZE, 20*l.***, for "Bragg," chesnut, 6 years-old; bred by Mr. Wrinch, Alwarton, Ipswich, Suffolk; sire, "Royal Duke;" dam, "Nell."

Suffolk Fillies.

JOHN WARD, East Mersea, Colchester, Essex: **FIRST PRIZE, 15*l.***, for his chesnut, 2 years 3 months-old; bred by himself; sire, "Briton;" dam, by Gloster Colonel.

MANFRED BIDDLE, Playford, Ipswich, Suffolk: **SECOND PRIZE, 10*l.***, for "May Bird," chesnut, 2 years 2 months-old; bred by himself; sire, "Confidence;" dam, "Dappa."

EDWARD GOWRING HODGSON, Charsfield Hall, Wickham Market, Suffolk: the *Reserved Number*, to his chesnut, 2 years 3 months-old; sire, "Hero;" dam, "Scott."

SHEEP.

Leicester Rams.

LIEUTENANT-COLONEL WILLIAM INGE, Thorpe Constantine, Tamworth, Staffordshire: **FIRST PRIZE, 20*l.***, for his 1 year 4 months-old; bred by himself; sire, "O. W."

WILLIAM SANDAY, Holme Pierrepont, Nottingham: **SECOND PRIZE, 10*l.***, for his about 1 year 4 months-old; bred by himself; sire, "X."

WILLIAM SANDAY: **THIRD PRIZE, Silver Medal**, for his about 1 year 4 months-old; bred by himself; sire, "M. Y."

JOHN BORTON, of Barton House, Barton-le-street, Malton : the *Reserved Number*, to his 1 year 3 months-old ; bred by himself.

JOHN BORTON : FIRST PRIZE, 20*l.*, for his 2 years 3 months-old ; bred by himself.

JOHN BORTON : SECOND PRIZE, 10*l.*, for his 5 years 3 months-old ; bred by himself.

JOHN BORTON, THIRD PRIZE, Silver Medal, for his 2 years 4 months-old ; bred by Mr. Sanday, Holme Pierrepont, Notts.

ROBERT WARD CRESWELL, Ravenstone, Ashby-de-la-Zouch, Leicestershire : the *Reserved Number*, to his 2 years 4 months-old ; bred by himself.

Leicester Ewes—Pens of Five.

LIEUTENANT-COLONEL WILLIAM INGE, Thorpe Constantine, Tamworth, Staffs. : FIRST PRIZE, 15*l.*, for his 1 year 4 months-old ; bred by himself.

WILLIAM SANDAY, Holme Pierrepont, Notts : SECOND PRIZE, 10*l.*, for his about 1 year 4 months-old ; bred by himself.

WILLIAM SANDAY : the *Reserved Number*, to his about 1 year 4 months-old ; bred by himself.

Cotswold Rams.

ROBERT GARNE, Aldsworth, Northleach, Gloucestershire : FIRST PRIZE, 20*l.*, for his 1 year 4 months-old ; bred by himself.

ROBERT GARNE : SECOND PRIZE, 10*l.*, for his 1 year 4 months-old ; bred by himself.

ROBERT GARNE : THIRD PRIZE, Silver Medal, for his 1 year 4 months-old ; bred by himself.

EDWARD HANDY, Sierford, Cheltenham, Gloucestershire : the *Reserved Number*, to his 1 year 3 months 2 weeks-old ; bred by himself.

ROBERT GARNE, Aldsworth, Northleach : FIRST PRIZE, 20*l.*, for his 3 years 4 months-old ; bred by himself.

THOMAS BEALE BROWNE, Salperton Park, Andoversford, Gloucestershire : SECOND PRIZE, 10*l.*, for his 2 years 4 months-old ; bred by himself.

EDWARD HANDY, Sierford, Cheltenham : the *Reserved Number*, to his 3 years 3 months 2 weeks-old ; bred by himself.

EDWARD HANDY : the *Reserved Number*, to his 4 years 3 months and 2 weeks-old ; bred by himself.

Cotswold Ewes—Pens of Five.

GEORGE FLETCHER, Shipton Sollars, Cheltenham : FIRST PRIZE, 15*l.*, for his 1 year 3 months and 2 weeks-old ; bred by himself.

WILLIAM LANE, Broadfield Farm, Northleach, Gloucestershire : SECOND PRIZE, 10*l.*, for his 1 year 3 months and 2 weeks-old ; bred by himself.

ROBERT GARNE, Aldsworth, Northleach : THIRD PRIZE, Silver Medal, for his 1 year 3 months and 2 weeks-old ; bred by himself.

GEORGE FLETCHER, Shipton Sollars, Cheltenham : the *Reserved Number*, to his 1 year 3 months and 2 weeks-old ; bred by himself.

Lincoln and other Long-woolled Rams.

JOHN LYNN, Church Farm, Stroxtton, Grantham, Lincolnshire : FIRST PRIZE, 20*l.*, for his 1 year and 4 months-old (Lincoln and Leicester) ; bred by himself ; sire, "Royal Leeds."

Award of Live-Stock Prizes at Worcester.

lv

THOMAS CARTWRIGHT, Dunston Pillar, Lincoln : SECOND PRIZE, 10*l.*, for his 1 year and 4 months-old (Lincoln); bred by himself.

JOSEPH SIMPSON, Spofforth Park, Wetherby, Yorkshire : THIRD PRIZE, Silver Medal, for his 1 year and 3 months-old; bred by himself.

CLARKE HALES, Bassingbourne, Royston, Cambridgeshire : the *Reserved Number*, to his 1 year and 4 months-old (Lincoln); bred by himself.

JOHN LYNN, Church Farm, Stroxtun, Grantham : FIRST PRIZE, 20*l.*, for "Battersea Royal," 2 years and 4 months-old (Lincoln and Leicester); bred by himself.

JOHN LYNN : SECOND PRIZE, 10*l.*, for his 2 years and 4 months-old (Lincoln and Leicester); bred by himself.

THOMAS BUMPSTEAD MARSHALL, Branston, Lincoln : THIRD PRIZE, Silver Medal, for his 2 years and 4 months-old (Lincoln); bred by himself.

JOSEPH SIMPSON, Spofforth Park, Wetherby : the *Reserved Number*, to his 2 years 2 months and 1 day-old; bred by himself.

Lincoln and other Long-woolled Ewes—Pens of Five.

ROBERT GEORGE FREDERICK HOWARD, Temple Bruer, Lincoln : FIRST PRIZE, 15*l.*, for his 1 year and 4 months-old (Lincoln); bred by himself.

THOMAS BUMPSTEAD MARSHALL, Branston, Lincoln : SECOND PRIZE, 10*l.*, for his 1 year and 4 months-old (Lincoln); bred by himself.

ROBERT GEORGE FREDERICK HOWARD, Temple Bruer, Lincoln : the *Reserved Number*, to his 1 year and 4 months-old (Lincoln); bred by himself.

Oxfordshire Down Rams.

JOHN BRYAN, Southleigh, Witney, Oxon : FIRST PRIZE, 20*l.*, for his 1 year 4 months and 1 week-old; bred by himself.

CHARLES GILLETT, Cote House, Bampton, Faringdon : SECOND PRIZE, 10*l.*, for his 1 year 4 months 3 weeks and 4 days-old; bred by himself.

JOSEPH DRUCE, Eynsham, Oxford : THIRD PRIZE, Silver Medal, for his 1 year 4 months and 2 weeks-old; bred by himself.

CHARLES GILLETT, Cote House, Bampton, Faringdon : the *Reserved Number*, to his 1 year 4 months and 3 weeks-old; bred by himself.

GEORGE WALLIS, Old Shifford, Bampton, Faringdon : FIRST PRIZE, 20*l.*, for his 3 years 5 months and 2 weeks-old; bred by himself.

GEORGE WALLIS : SECOND PRIZE, 10*l.*, for his 2 years 5 months and 2 weeks-old; bred by himself.

GEORGE WALLIS : THIRD PRIZE, Silver Medal, for his 2 years 5 months and 2 weeks-old; bred by himself.

GEORGE HENRY BARNETT, Glympton Park, Woodstock, Oxon : the *Reserved Number*, to his 2 years 3 months and 2 weeks-old; bred by himself.

Oxfordshire Down Ewes—Pens of Five.

CHARLES GILLETT, Cote House, Bampton, Faringdon : FIRST PRIZE, 15*l.*, for his about 1 year 4 months and 3 weeks-old; bred by himself.

THE DUKE OF MARLBOROUGH, Blenheim Palace, Woodstock : SECOND PRIZE, 10*l.*, for his 1 year 3 months and 3 weeks-old; bred by himself.

CHARLES GILLETT, Cote House, Bampton, Faringdon : the *Reserved Number* to his about 1 year 4 months 1 week and 1 day-old; bred by himself.

South Down Rams.

- LORD WALSINGHAM, Merton Hall, Thetford, Norfolk: FIRST PRIZE, 20*l.*, for his 1 year 3 months and 2 weeks-old; bred by himself.
- LORD WALSINGHAM: SECOND PRIZE, 10*l.*, for his 1 year 3 months and 2 weeks-old; bred by himself.
- LORD WALSINGHAM: THIRD PRIZE, Silver Medal, for his 1 year 3 months and 2 weeks-old; bred by himself.
- LORD WALSINGHAM: the *Reserved Number*, to his 1 year 3 months and 2 weeks-old; bred by himself.
- LORD WALSINGHAM: FIRST PRIZE, 20*l.*, for his 4 years 3 months and 2 weeks-old; bred by himself.
- LORD WALSINGHAM: SECOND PRIZE, 10*l.*, for his 2 years 3 months and 2 weeks-old; bred by himself.
- LORD WALSINGHAM: THIRD PRIZE, Silver Medal, for his 2 years 3 months and 2 weeks-old; bred by himself.
- LORD WALSINGHAM: the *Reserved Number*, to his 2 years 3 months and 2 weeks-old; bred by himself.

South-Down Ewes—Pens of Five.

- LORD WALSINGHAM: FIRST PRIZE, 15*l.*, for his 1 year 3 months and 2 weeks-old; bred by himself.
- JOHN and ALFRED HEASMAN, of Angmering, Arundel, Sussex: SECOND PRIZE, 10*l.*, for their 1 year and 4 months-old; bred by themselves.
- JAMES JOHN FARQUHARSON, Langton House, Blandford, Dorset: THIRD PRIZE, Silver Medal, for his 1 year and 4 months-old; bred by himself.
- THE EARL OF RADNOR, Coleshill, Highworth, Wilts: the *Reserved Number*, to his 1 year and 4 months-old; bred by himself.

Shropshire Rams.

- JOHN STUBBS, Weston Hall, Stafford: FIRST PRIZE, 20*l.*, for "Earl of Shrewsbury," 1 year 4 months 3 weeks and 6 days-old; bred by himself.
- THOMAS HORTON, Harnage Grange, Shrewsbury: SECOND PRIZE, 10*l.*, for "Quality," 1 year and 4 months-old; bred by himself; sire, "Duke of Kent."
- THOMAS HORTON, THIRD PRIZE, Silver Medal, for "Captain Semmes," 1 year 3 months and 2 weeks-old; bred by himself; sire, "Sir Henry."
- WILLIAM ORME FOSTER, Kinver Hill Farm, Stourbridge, Worcestershire: the *Reserved Number*, to his 1 year and 4 months-old; bred by himself.
- PRYCE WILLIAM BOWEN, Shrawardine Castle, Shrewsbury: FIRST PRIZE, 20*l.*, for his 2 years 3 months and 2 weeks-old; bred by himself; sire, "Preece's Patron."
- COLONEL DYOTT, Freeford Hall, Lichfield, Staffordshire, SECOND PRIZE, 10*l.*, for his 2 years 3 months and 3 week-old; bred by himself; sire, "Patent."
- JOHN COXON, Freeford, Lichfield, Staffordshire: THIRD PRIZE, Silver Medal, for "Nobleman," 3 years 3 months and 2 weeks-old; bred by himself; sire, "Patent."
- ROBERT HANBURY MASFEN, Pendeford, Wolverhampton, Staffordshire: the *Reserved Number*, to his "Magic," 3 years and 3 months-old; bred by himself; sire, "Old Cross."

Shropshire Ewes—Pens of Five.

JAMES and EDWARD CRANE, Shrawardine, Shrewsbury: FIRST PRIZE, 15*l.*, for their 1 year 2 months and 1 week-old; bred by themselves; sire, "Caradoc."

JAMES and EDWARD CRANE: SECOND PRIZE, 10*l.*, for their 1 year and 3 months-old; bred by themselves; sire, "Caradoc."

HENRY MATTHEWS, Montford, Shrewsbury: THIRD PRIZE, Silver Medal, for his 1 year and 3 months-old; bred by himself.

JOHN HANBURY BLACKBURN, Pipe-place, Lichfield, Staffordshire: the *Reserved Number*, to his 1 year 3 months and 3 weeks-old; bred by himself.

Hampshire and other Short-woolled Rams.

WILLIAM HUMFREY, Oak Ash, Chaddleworth, Wantage, Berks: FIRST PRIZE, 20*l.*, for his 1 year and 5 months-old (West Country Down); bred by himself.

WILLIAM HUMFREY: SECOND PRIZE, 10*l.*, for his 1 year and 4 months-old (West Country Down); bred by himself.

WILLIAM BROWNE CANNING, Elston Hill, Devizes, Wilts: THIRD PRIZE, Silver MEDAL, for his 1 year 4 months and 2 weeks-old (West Country Down); bred by himself.

JAMES RAWLENCE, Bulbridge, Wilton, Salisbury, Wilts: the *Reserved Number*, to his "Tim Whiffer," 1 year and 5 months-old (West Country Down); bred by himself.

JAMES RAWLENCE: FIRST PRIZE, 20*l.*, for his "Maccaroni," 3 years 3 months and 1 week-old (West Country Down); bred by himself.

WILLIAM HUMFREY, Oak Ash, Chaddleworth, Wantage, Berks: SECOND PRIZE, 10*l.*, for his 3 years and 4 months-old (West Country Down); bred by himself.

WILLIAM HUMFREY: the *Reserved Number*, to his 4 years 4 months and 1 week-old (West Country Down); bred by himself.

Hampshire and other Long-woolled Ewes—Pens of Five.

JAMES RAWLENCE, Bulbridge, Wilton, Salisbury, Wilts: FIRST PRIZE, 15*l.*, for his 1 year 4 months and 2 weeks-old (West Country Down); bred by himself.

JAMES RAWLENCE: SECOND PRIZE, 10*l.*, for his 1 year and 4 months-old (West Country Down); bred by himself.

JAMES RAWLENCE: the *Reserved Number*, to his 1 year and 4 months-old (West Country Down); bred by himself.

PIGS.

Boars of a Large Breed, of any colour.

WILLIAM BRADLEY WAINMAN, Carhead, Crosshills, Yorkshire: FIRST PRIZE, 10*l.*, for "Worcester Duke" (late "Albert"), white, 8 years and 10 months-old (Improved Lancashire and Yorkshire); bred by John Goodwin, Norbury, Stockport.

RICHARD DICKIN, 161, Old Road, Stockport, Lancashire: **SECOND PRIZE, 5*l.***, for "John," white, 2 years and 1 month-old; bred by John Harrison, Heaton Norris, Stockport; sire, "Young Albert;" dam, "Betsy."

Boars of a Small White Breed.

WILLIAM BRADLEY WAINMAN, Carhead, Crosshills, Yorkshire: **FIRST PRIZE, 10*l.***, for "King Cube," 2 years 8 months 1 week and 3 days-old (Carhead); bred by himself.

ROBERT BERKELEY, Spetchley Park, Worcester: **SECOND PRIZE, 5*l.***, for his 9 months and 5 days-old (Improved Yorkshire); bred by himself.

GEORGE MANGLES, Givendale, Ripon, Yorkshire: **THIRD PRIZE, Silver Medal**, for "Cupid," 1 year 6 months 3 weeks and 2 days-old (Yorkshire and Cumberland); bred by himself; sire, "King of Diamonds;" dam, "Princess."

GEORGE MANGLES: the *Reserved Number*, to "Brutus," 1 year 6 months 3 weeks and 2 days-old (Yorkshire and Cumberland); bred by himself; sire, "King of Diamonds;" dam, "Princess."

Boars of a Small Black Breed.

THOMAS CRISP, Butley Abbey, Wickham Market, Suffolk: **FIRST PRIZE, 10*l.***, for his 11 months 1 week and 5 days-old (Improved Suffolk); bred by himself.

GEORGE MUMFORD SEXTON, Wherstead Hall, Ipswich, Suffolk: **SECOND PRIZE, 5*l.***, for "Go-a-head," 7 months 2 weeks and 1 day-old (Suffolk); bred by himself; sire, "Terror;" dam, "Canterbury Lass 3rd."

GEORGE MUMFORD SEXTON: the *Reserved Number*, to "Lord Clifden," 7 months 2 weeks and 3 days-old (Suffolk); bred by himself; sire, "The Earl;" dam, "Shortnose."

Boars of the Berkshire Breed.

WILLIAM HEWER, Sevenhampton, Highworth, Wilts: **FIRST PRIZE, 10*l.***, for his black and white 9 months-old; bred by himself; sire, "Warwick;" dam, "Miss Wells."

WILLIAM HEWER: **SECOND PRIZE, 5*l.***, for his black and white 9 months and 3 weeks-old; bred by himself; sire, "Warwick;" dam, "Jenny."

WILLIAM JOYCE, Abbey Farm, Waterford, Ireland: **THIRD PRIZE, Silver Medal**, for his 5 months 1 week and 1 day-old; bred by himself; sire, "Sir Robert;" dam, "Gipsy 2nd."

WILLIAM JOYCE: the *Reserved Number*, to his 5 months 1 week and 1 day-old; bred by himself; sire, "Sir Robert;" dam, "Gipsy 2nd."

Boars of a Breed not eligible for the preceding Classes.

WILLIAM BRADLEY WAINMAN, Carhead, Cross Hills, Yorkshire: **FIRST PRIZE, 10*l.***, for "The Nabob," white, 1 year 10 months 3 weeks and 4 days-old (Carhead middle); bred by himself.

JAMES GRAHAM, 1, Blackburn's Buildings, York Road, Leeds: **SECOND PRIZE, 5*l.***, for "Pride of Leeds," white, 2 years 2 months and 3 days-old (middle); bred by Mr. Rinder, Sheepscar, Leeds; sire, "Cupid;" dam, "Julia."

WILLIAM BRADLEY WAINMAN, Carhead, Cross Hills, Yorkshire: the *Reserved Number*, to "British Workman," white, 10 months 3 weeks and 1 day-old (Carhead middle); bred by himself.

Breeding Sows of a Large Breed, of any colour.

WILLIAM BRADLEY WAINMAN, Carhead, Crosshills, Yorkshire : FIRST PRIZE, 10*l.*, for "Fresh Hope," white, about 2 years-old (Yorkshire); bred by Messrs. Hey, Beamaley, Skipton-in-Craven, Yorkshire; sire, "Flag of Truce."

RICHARD DICKIN, 161, Old Road, Stockport, Lancashire : SECOND PRIZE, 5*l.*, for "Miss Watts," white, 2 years 1 month 2 weeks and 5 days-old : bred by Sir James Watts, Bart, Abney Hall, Cheadle, Cheshire; sire, "Victory;" dam, "Elizabeth."

WILLIAM EARDLEY, Larkton Hall, Malpas, Cheshire : the *Reserved Number*, to "Mary Frances," white, 1 year 5 months and 2 days-old (Cheshire); bred by himself; dam, "Cheshire Lass."

Breeding Sows of a Small White Breed.

THOMAS CRISP, Butley Abbey, Wickham Market, Suffolk : FIRST PRIZE, 10*l.*, for his 2 years 3 months and 3 weeks-old (Suffolk); bred by himself.

SIR EDWARD KERRISON, Bart., M.P., Brome Hall, Scole, Suffolk : SECOND PRIZE, 5*l.*, for "Annie Laurie," 2 years and 10 months-old; bred by himself; sire, "Brome Prince;" dam, "Miss Ritter."

SAMUEL GEATER STEARN, Brandeston, Wickham Market, Suffolk : THIRD PRIZE, Silver Medal, for "Victoria 2nd," 1 year 2 months 3 weeks and 2 days-old (Suffolk); bred by himself; sire, "Marquis;" dam, "Victoria."

MICHAEL GAVINS, Fox Inn, Leeds, Yorkshire : the *Reserved Number*, to "Eugénie," 2 years 1 month 3 weeks and 2 days-old; bred by himself; sire, Lord Wenlock's "Cato;" dam, Prince Consort's "Windsor Lass."

Breeding Sows of a Small Black Breed.

THOMAS CRISP, Butley Abbey, Wickham Market, Suffolk : FIRST PRIZE, 10*l.*, for his 11 months 1 week and 5 days-old (Improved Suffolk); bred by himself.

GEORGE MUMFORD SEXTON, Wherstead Hall, Ipswich, Suffolk : SECOND PRIZE, 5*l.*, for "Marigold," 1 year and 2 months-old (Suffolk); bred by himself; sire, "Pug;" dam, "Pet."

WILLIAM HEMMING, Coldicott, Moreton-in-Marsh, Gloucestershire : THIRD PRIZE, Silver Medal, for "The Bride of Elmwood," 1 year 1 month 1 week and 3 days-old; bred by himself; sire, "Sherborne Prince 2nd;" dam, "Tillesley 2nd."

THOMAS CRISP, Butley Abbey, Wickham Market, Suffolk : the *Reserved Number*, for his 11 months 1 week and 5 days-old (Improved Suffolk); bred by himself.

Breeding Sows of the Berkshire Breed.

WILLIAM JAMES SADLER, Bentham, Calcutt, Cricklade, Wilts : FIRST PRIZE, 10*l.*, for "Alexandra," dark, 2 years 2 weeks and 1 day-old; bred by himself; sire, "King of Warwick;" dam, "Bracebridge 3rd."

JOHN HITCHMAN, M.D., Mickleover, Derby : SECOND PRIZE, 5*l.*, for "Lady Bowly," black, with white feet, 3 years 11 months 3 weeks and 1 day-old; bred by Edward Bowly, Siddington House, Cirencester, Gloucestershire.

ROYAL AGRICULTURAL COLLEGE, Cirencester, Gloucestershire : THIRD PRIZE, Silver Medal, for "Polly," black, 1 year 5 months and 4 weeks-old; bred by himself; sire, "Duke of Glo'ster;" dam, "Mrs. Joshua."

GEORGE MANDEE ALLENDER, Lee Grange, Winslow, Bucks: the *Reserved Number*, for "Topsy," black, 10 months and 5 days-old; bred by himself; sire, "Glos'ter;" dam, "Darkie."

Breeding Sows of a Breed not eligible for the preceding Classes.

THOMAS CRISP, Butley Abbey, Wickham Market, Suffolk: **FIRST PRIZE**, 10*l.*, for his white 2 years 1 month and 4 days-old (middle); bred by himself.

WILLIAM BRADLEY WAINMAN, Carhead, Crosshills, Yorkshire: **SECOND PRIZE**, 5*l.*, for "The Happy Link," white, 1 year 7 months 1 week and 6 days-old (Carhead Middle); bred by himself.

WILLIAM BRADLEY WAINMAN: **THIRD PRIZE**, Silver Medal, for "The Lucky Link," white, 1 year 7 months 1 week and 6 days-old (Carhead Middle); bred by himself.

JAMES GRAHAM, 1, Blackburn's Buildings, York Road, Leeds, Yorkshire: the *Reserved Number*, for "Dew Drop," white, 1 year 8 months and 2 weeks-old (middle); bred by Mr. Myers, Sheepscar, Leeds, Yorkshire; sire, "Young Sir Colin;" dam, "Lily of the Valley."

Sow Pigs of a Large Breed—Pens of Three.

WILLIAM BRADLEY WAINMAN, Carhead, Crosshills, Yorkshire: **FIRST PRIZE**, 10*l.*, for "Advance Symmetry," "Advance Quality," and "No Surrender," white, 7 months and 5 days-old (Carhead); bred by himself.

RICHARD ELMHURST DUCKERING, Northorpe Station, Kirton Lindsey, Lincolnshire: **SECOND PRIZE**, 5*l.*, for his white, 7 months and 2 weeks-old (Lincolnshire); bred by himself; sire, "Victor;" dam, "Victoria."

Breeding Sow Pigs of a Small White Breed—Pens of Three.

JOHN WATERS, Motcombe, Eastbourne, Sussex: **FIRST PRIZE**, 10*l.*, for his 7 months and 3 weeks-old; bred by himself; sire, "Windsor Prince;" dam, "The Watson Sow."

THE HON. COLONEL E. G. D. PENNANT, M.P., Penrhyn Castle, Bangor, Carnarvonshire: **SECOND PRIZE**, 5*l.*, for his 7 months 3 weeks and 4 days-old; bred by himself; sire, "Wiley's Boar;" dam, "Mary."

MAJOR-GENERAL THE HON. A. NELSON HOOD, Cumberland Lodge, Windsor, Berkshire: the *Reserved Number*, to his 7 months 3 weeks and 3 days-old (Prince Albert's Windsor); bred by himself; sire, "Duke;" dam, "Windsor."

Breeding Sow Pigs of a Small Black Breed—Pens of Three.

GEORGE MUMFORD SEXTON, Whorstead Hall, Ipswich, Suffolk: **FIRST PRIZE**, 10*l.*, for "Confidence bestows Success," 7 months and 3 days-old (Suffolk); bred by himself; sire, "Battersea Prince;" dam, "Splendour."

WILLIAM HEMMING, Caldicott, Moreton-in-Marsh, Gloucestershire: **SECOND PRIZE**, 5*l.*, for "Neatness," "Nicety," and "Notable," 7 months 1 week and 3 days-old; bred by himself; sire, "Mr. Windham;" dam, "Miss Holdway 4th."

JOHN AZARIAH SMITH, Bradford Peverell, Dorchester, Dorset: the *Reserved Number*, to his 3 months and 3 weeks-old (Improved Dorset); bred by himself.

Breeding Sow Pigs of the Berkshire Breed—Pens of Three.

WILLIAM JOYCE, Abbey Farm, Waterford, Ireland: FIRST PRIZE, 10*l.*, for his 7 months and 1 week-old: bred by himself; sire, "Emperor;" dam, "Nelly."

JOSEPH SMITH, Henley-in-Arden, Warwickshire: SECOND PRIZE, 5*l.*, for his black, with a little white, 7 months 3 weeks and 3 days-old; bred by himself: sire, "Gannaway;" dam, "Favourite."

WILLIAM JAMES SADLER, Benthams, Calcott, Cricklade, Wilts: THIRD PRIZE, Silver Medal, for his dark, 7 months and 4 days-old; bred by himself; sire, "Garibaldi;" dam, "Daughter of Heavysides."

WILLIAM JOYCE, Abbey Farm, Waterford, Ireland: the *Reserved Number*, for his 5 months 1 week and 1 day-old; bred by himself; sire, "Sir Robert;" dam, "Gipsy 2nd."

*Breeding Sow Pigs of a Breed not eligible for the preceding Classes—
Pens of Three.*

WILLIAM BRADLEY WAINMAN, Carhead, Crosshills, Yorkshire: FIRST PRIZE, 10*l.*, for his 6 months 3 weeks and 1 day old (Carhead Middle); bred by himself.

HENRY KEYWORTH, Woodhouse Moor, Leeds, Yorkshire: SECOND PRIZE, 5*l.*, for his white, 5 months and 3 weeks-old (middle); bred by himself; sire, "Pride of Leeds;" dam, "Lily of the Valley."

JOSEPH GLEDHILL, High-street, Heckmondwicke, Yorkshire: the *Reserved Number*, for "The Three Lilies," white, 7 months 1 week and 4 days-old (Yorkshire Middle); bred by himself; dam, "Fair Flora."

SPECIAL PRIZES OFFERED BY THE WORCESTER
LOCAL COMMITTEE.

SHORTHORNS.

Pairs of Cows In-milk.

RICHARD BOOTH, Warlaby, Northallerton, Yorkshire: FIRST PRIZE, 15*l.*, for "Queen of the Ocean," red and white, 4 years 7 months 3 weeks and 4 days-old; bred by himself; sire, "Crown Prince" (10087); dam, "Red Rose:" "Soldier's Bride," white, 4 years 5 months 3 weeks and 1 day-old; bred by himself; sire, "Windsor" (14013); dam, "Campfollower."

JAMES HAUGHTON LANGSTON, M.P., Sarsden House, Chipping Norton, Oxfordshire: SECOND PRIZE, 5*l.*, for "Dandelion," white, 4 years 6 months and 3 days-old; bred by himself; sire, "Gloster's Grand Duke" (12949); dam, "Daisy:" "Merrytrix," red and white, 4 years 3 months and 5 days-old; bred by himself; sire, "Gloster's Grand Duke" (12949); dam, "Merrytrix."

Pairs of Heifers In-milk and In-calf.

JOHN R. MIDDLEBROUGH, South Milford, Milford Junction, Yorkshire: FIRST PRIZE, 15*l.*, for his red and white, 8 years and 11 months old; bred by himself; sire, "The Squire;" dam, "Red Rose:" roan, 8 years old; bred by himself; sire, "The Squire;" dam, "Red Rose."

WILLIAM BRADBURN, Hilton, Wolverhampton, Staffordshire : SECOND PRIZE, 5*l.*, for "Flora," light roan, 3 years 11 months and 3 weeks old ; bred by the late Joshua Price, Featherstone, Wolverhampton ; sire, "Sultan" (15355) ; dam, "Oak Apple" : "Snowdrop," roan, 3 years and 3 months-old ; bred by the late Joshua Price ; sire, "Sultan" (15355) ; dam, "Snowball."

Pairs of Heifers In-calf.

RICHARD BOOTH, Warlaby, Northallerton, Yorkshire : FIRST PRIZE, 15*l.*, for "Graceful," roan, 2 years 10 months and 1 week-old ; bred by himself ; sire, "Prince Alfred" (13494) ; dam, "Lady Grace." "Lady Joyful," roan, 2 years and 4 months old ; bred by himself ; sire, "Lord of the Valley" (14837) ; dam, "Lady Blithe."

EARL BEAUCHAMP, of Madresfield Court, Great Malvern, Worcestershire : SECOND PRIZE, 5*l.*, for "Princess Royal," roan, 2 years and 4 months-old ; bred by himself ; sire, "Ortolan" (18496) ; dam, "Pollyhorton." "Sunshine," roan, bred by himself ; sire, "Ortolan" (18496) ; dam, "Gaylass."

Pairs of Yearling Heifers.

COLONEL CHARLES TOWNELEY, Towneley Park, Burnley, Lancashire : FIRST PRIZE, 10*l.*, for "Double Butterfly," roan, 1 year 5 months 1 week and 2 days-old ; bred by himself ; sire, "Royal Butterfly" (16862) ; dam, "Alice Butterfly." "Perfume," white, 1 year 2 months and 1 week-old ; bred by himself ; sire, "Baron Hopewell" (14134) ; dam, "Pride."

Bull, Cow, and their Offspring.

RICHARD STRATTON, Walls Court, Stapleton, Bristol : FIRST PRIZE, 10*l.*, for his bull, "Knight of the Lagan," roan, 4 years and 2 months-old ; bred by Mr. Richardson, Glenmore, Ireland : cow, "Lady Hinda," roan, 4 years 1 month and 1 week-old ; bred by himself : offspring, 1 month and 2 days-old ; bred by himself.

JAMES HAUGHTON LANGSTON, Saraden House, Chipping Norton, Oxfordshire : SECOND PRIZE, 10*l.*, for his bull, "Lord of the Harem" (16430), roan, 4 years 7 months 3 weeks and 1 day-old ; bred by Mr. Housman, Lane Bank, Lancaster ; sire, "Duke of Buckingham" (14428) ; dam, "Gulnare." cow, "Sally," red, 7 years 3 months and 2 days-old ; bred by himself ; sire, "Grand Duke" (12949) ; dam, "Silky." offspring, "Harems Select," roan, 8 months and 2 weeks-old ; bred by himself.

HEREFORDS.

Pairs of Cows In-milk.

JOHN WALKER, Westfield House, Holmer, Hereford : FIRST PRIZE, 15*l.*, for "Alice Grey," red with white face, 6 years 3 weeks and 3 days-old ; bred by John Hewer, Marden, Hereford ; sire, "Garrick" ; dam, "Silver Beauty." "Nell Gwynne," red with white face, 5 years 5 months 2 weeks and 2 days-old ; bred by John Hewer ; sire, "Darling 2nd" ; dam, "Platina."

PHILIP TURNER, The Leen, Pembridge, Herefordshire : SECOND PRIZE, 5*l.*, for "Jewel," red with white face, 4 years 11 months 2 weeks and 3 days-old ; bred by himself ; sire, "Felix" (953) ; dam, "Brilliant" (619) : "Juliet," red with white face, 4 years 10 months 2 weeks and 2 days-old ; bred by himself ; sire, "Felix" (953) ; dam, "Bellona."

GEORGE PITT, Chadnor Court, Dilwyn, Leominster, Herefordshire: the *Reserved Number*, to "Perfection," red with white face, 7 years 4 months 1 week and 4 days-old; bred by himself; sire, "Plunder;" dam, "Brandy;" "Stately," red, with white face, 5 years 7 months and 2 days-old; bred by himself; sire, "Riff Raff;" dam, "Duchess."

Pairs of Heifers In-milk or In-calf.

THE EXECUTORS OF THE LATE JAMES REA, Monaughty, Knighton, Radnorshire: FIRST PRIZE, 15*l.*, for "Diana the Second," red with white face and mane, 3 years 10 months 2 weeks and 3 days-old; bred by the late J. Rea; sire, "Wellington;" dam, "Diana;" "Spangle the 2nd," red with white face and mane, 3 years 9 months and 2 weeks-old; bred by the late J. Rea; sire, "Wellington;" dam, "Spangle."

HENRY RAWLINS EVANS, jun., Swanstone Court, Dilwyn, Leominster, Herefordshire: SECOND PRIZE, 5*l.*, for "Nelly," red with white face, 3 years 9 months and 1 week-old; bred by himself; sire, "Rambler" (1046); dam, "Silver 2nd;" "Stately 2nd," red, with white face, 3 years 3 months 2 weeks and 1 day-old; bred by himself; sire, "Rambler" (1046); dam, "Stately."

Bull, Cow, and their Offspring.

THOMAS ROBERTS, Ivington Bury, Leominster, Herefordshire: FIRST PRIZE, 20*l.*, for his bull, "Sir Thomas" (2228), red with white face, 3 years 5 months 3 weeks and 5 days-old; bred by himself; sire, "Sir Benjamin;" dam, "Lady Ann Page" (213); cow, "Prize Flower Page" (263), red, with white face, 5 years 10 months and 2 weeks-old; bred by himself; sire, "Arthur Napoleon" (910); dam, "Longhorns" (145): offspring, heifer, red with white face, 8 months and 3 weeks-old; bred by himself.

HENRY GIBBONS, Hampton Bishop, Hereford: SECOND PRIZE, 10*l.*, for his bull, "Shamrock the Second," red with white face, 3 years 9 months 3 weeks and 6 days-old; bred by E. Price, Court House, Pembridge, Herefordshire; sire, "Shamrock;" dam, "Creeping Jenny;" cow, "Pretty-maid," red with white face, 7 years 8 months 1 week and 6 days-old; bred by himself; sire, "The Admiral;" dam, "Hoop;" offspring, red with white face, 6 months 1 week and 2 days-old; bred by himself.

THOMAS DAVIS, Burliton Court, Hereford: the *Reserved Number*, to his bull "Courtier," red with white face, 6 years 9 months and 3 weeks-old; bred by Mr. Price, Court House, Pembridge; sire, "Goldfinder the Second;" cow, "Miss Knight," red with white face, 5 years-old; bred by himself; sire, "Darling;" offspring, "Burliton," red, with white face, 1 month and 4 weeks-old; bred by himself.

Bull, and a Cow In-milk, of the Welsh Breed.

RICHARD HART HARVEY, Harroldstone, Haverfordwest: FIRST PRIZE, 10*l.*, for his bull (Anglesey) "Ap Shenkin," black, 3 years and 11 months-old; bred by Hugh Hughes, Aber Ogwen, Bangor: cow (Anglesey), "Annie Laurie," black, 4 years and 3 months-old; bred by Humphrey Ellis, Cefnfaes, Bangor.

Bull, and a Cow In-milk, of any pure Scotch Breed.

THE EARL OF POWIS, Powis Castle, Welshpool, Montgomeryshire: FIRST PRIZE, 10*l.*, for his bull (Ayrshire) "Irvine," dark red and white, 2 years and 11 months-old; bred by John Parker, Broomlands, Irvine, Ayrshire: cow, (Ayrshire), "Bonny Jean," red and white spotted, 6 years 3 months and 3 days-old; bred by himself; sire, "Duke."

HORSES.

Hunter and Hackney—Mares or Geldings.

JOHN B. BOOTH, Killerby, Catterick, Yorkshire: FIRST PRIZE, 20*l.*, for his half-bred hunter-gelding, "Beechwood," bay, 5 years-old; bred by Smart Atkinson, Beaumont Hill, Darlington; sire, "Lancewood."

JOHN GREGORY WATKINS, Woodfield, Droitwich, Worcestershire: SECOND PRIZE, 10*l.*, for his half-bred mare, "Elastic," bay, 5 years-old; bred by himself; sire, "Teddington;" dam, "Crasher."

EDWARD VINCENT WHEELER, Kyrewood House, Tenbury, Worcestershire: the *Reserved Number*, to his half-bred gelding, chesnut, 9 years-old; bred by himself; sire, "Young Colwick;" dam, "Fanny."

Hunter and Hackney—Fillies or Geldings.

HENRY JAMES SHELDON, Brailes House, Shipston-on-Stour, Warwickshire: FIRST PRIZE, 10*l.*, for his gelding, "Harold," brown, 3 years and 1 month-old; bred by himself; sire, "Barnton;" dam, "Black Bess."

JAMES WHITE, Lindoes, Coleford, Gloucestershire: SECOND PRIZE, 5*l.*, for his half-bred filly, "Brunette," brown, 3 years-old; bred by himself; sire, "Sir Peter Laurie;" dam, "Jessie."

JOHN PHILIP SMITH, Lower Wick, Worcester: the *Reserved Number*, to his chesnut filly, 3 years and 2 months-old; bred by himself; sire, "Canobie;" dam, "Bessy."

WILLIAM BAKER, Brailes, Shipston-on-Stour, Warwickshire: FIRST PRIZE, 10*l.*, for his half-bred gelding, "Grafton," light chesnut, 2 years and 1 month-old; bred by himself; sire, "Ethelbert."

HENRY ALLSOPP, Hindlip Hall, Worcester: SECOND PRIZE, 5*l.*, for his nearly thorough-bred gelding, "Parvenue," black, 2 years 2 months and 2 weeks-old; bred by himself; sire, "Great Unknown;" dam, "Patchwork."

JOHN HENRY ELWES, Colesbourn, Cheltenham: the *Reserved Number*, to his gelding, "Gold-dust," chesnut, 2 years-old; bred by himself; sire, "Lough Bawn."

Cobs.

FREDERICK BRANWHITE, Chapel House, Long Melford, Sudbury: FIRST PRIZE, 10*l.*, for his Norfolk gelding, "Tam o' Shanter," brown, 6 years-old; bred by Mr. Wibrew, Shumpling, Sudbury; sire, "Patten's horse."

FREDERICK BRANWHITE: SECOND PRIZE, 5*l.*, for his Norfolk gelding, "Quick-silver," chesnut, 5 years-old; bred by Mr. Manby, Sudbury; sire, "Young Fire King;" dam, "Beeswing."

Agricultural Stallions.

JOSEPH MILES, Astwood Claines, Worcester: FIRST PRIZE, 40*l.*, for "Iron Duke," dark brown, 4 years-old; bred by himself; sire, "Iron Duke;" dam, "Invincible."

JOHN CRUMP, Grafton, Beckford, Tewkesbury, Gloucestershire: SECOND PRIZE, 20*l.*, for "Young Waxwork," light red roan, 3 years 1 month and 2 weeks-old; bred by Mr. Attwood, Bromham, Wiltshire; sire, "Waxwork;" dam, "Frolic."

SHEEP.

Ryeland Ram.

JOHN BEARCROFT DOWNING, Holme Lacey, Hereford : FIRST PRIZE, 10*l.*, for his about 1 year and 3 months-old ; bred by himself.

JOHN BEARCROFT DOWNING : the *Reserved Number*, to his about 1 year and 3 months-old ; bred by himself.

Ryeland Theaves—Pens of Five.

JOHN BEARCROFT DOWNING, Holme Lacey, Hereford : FIRST PRIZE, 10*l.*, for his about 1 year and 3 months-old ; bred by himself.

Welsh or any other Mountain Breed Ram.

JONATHAN PEEL, Knowlmere Manor, Clitheroe : FIRST PRIZE, 10*l.*, for "Grand-son of the Mountain King" (pure Lonk), 2 years 3 months and 2 days-old ; bred by John Midgeley, Knowl Top, Clitheroe ; sire, "Prince of Pendle."

JAMES MERSON, Brinsworthy, North Molton, Devon : the *Reserved Number*, to his (pure Exmoor), white, 2 years and 4 months-old ; bred by himself.

Welsh or any other Mountain Breed Theaves—Pens of Five.

JONATHAN PEEL, Knowlmere Manor, Clitheroe : FIRST PRIZE, 10*l.*, for "Mountain Queens" (Nos. 75, 76, 78, 81, 98), (pure Lonk), 1 year 2 months and 2 weeks-old ; bred by himself ; sire, "Mountain King."

JONATHAN PEEL : the *Reserved Number*, to "Mountain Queens" (Nos. 62, 63, 64, 67, 69), (pure Lonk), 1 year 2 months and 2 weeks-old ; bred by himself ; sire, "Mountain King."

PIGS.

Large Breed Boar, Sow, and their Litter of Pigs.

WILLIAM BRADLEY WAINMAN, Carhead, Crosshills, Yorkshire : FIRST PRIZE, 10*l.*, for his (Carhead breed) boar, "Lord of the Wassail," white, 2 years and 3 months-old ; bred by himself : sow, "Bright Hope," white, about 4 years-old : litter of pigs, white, 11 weeks and 2 days-old ; bred by himself.

Small Breed Boar, Sow, and their Litter of Pigs.

TITUS BENNETT STEAD, 20, Upperhead Row, Leeds, Yorkshire : FIRST PRIZE, 10*l.*, for his boar, "Maccaroni," white, 1 year 1 week and 3 days-old ; bred by W. Newby, Leathley, Otley, Yorkshire ; sire, "Wenlock ;" dam, "Leathley Lass ;" sow, "Fairy," white, 1 year 5 months 2 weeks and 5 days-old ; bred by himself ; sire, "Sir Colin ;" dam, "Dewdrop ;" litter of pigs, white, 2 months and 1 week-old ; bred by himself.

JOHN AZARIAH SMITH, Bradford Peverell, Dorchester, Dorset : SECOND PRIZE, 5*l.*, for his (Improved Dorset) boar, black, 1 year and 6 months-old ; bred by himself : sow, black, 3 years 3 months and 2 weeks-old ; bred by himself : litter of pigs, black, 2 months and 1 week-old ; bred by himself.

SAMUEL GEATER STEARN, Brandeston, Wickham Market, Suffolk: the *Reserved Number*, to his (Suffolk) boar "His Highness," white, 6 years and 2 months old; bred by J. Catchpole, Letheringham, Wickham Market: sow, "Princess," white, 3 years-old; bred by himself: litter of pigs, 2 months 3 weeks and 1 day-old; bred by himself.

IMPLEMENTS.

STEAM-CULTIVATORS.

JOHN FOWLER, 28, Cornhill, London: the Prize of THIRTY SOVEREIGNS and a GOLD MEDAL, for his 14-Horse Set of Steam-Ploughing Machinery, complete; manufactured by himself.

SAVORY AND SON, High Orchard Iron Works, Gloucester: the Prize of TWENTY SOVEREIGNS, for their 10-Horse Patent Double-cylinder Self-propelling Winding Engine. It consists in applying a drum to revolve on friction wheels placed around the body of the boiler, and is capable of taking on at one lap 470 yards of wire rope; invented and manufactured by themselves.

WM. STEEVENS, No. 6, Godolphin-road, New-road, Hammersmith, Middlesex: a SILVER MEDAL, for his complete Set of New and Improved Apparatus for Cultivating the Land by Steam-power; invented and improved by himself, and manufactured by Garrett and Son.

COLEMAN AND SONS, Chelmsford, Essex: COMMENDED for their Set of Steam Cultivating Apparatus; invented by Yarrow and Hilditch, of London, improved and manufactured by themselves.

STEAM-CULTIVATORS FOR SMALL OCCUPATIONS.

JOHN FOWLER: the Prize of TWENTY-FIVE SOVEREIGNS, for his 10-Horse Set of Steam-ploughing Machinery, complete; manufactured by himself.

WILLIAM SMITH, Woolston, near Bletchley Station, Bucks: the Prize of FIFTEEN SOVEREIGNS, for his 10-Horse Power Engine, Double Cylinder; invented, improved, and manufactured by Mr. Butlin, of Northampton. Windlass, &c., complete, for Steam-ploughing.

JAMES AND FREDERICK HOWARD, the Britannia Iron Works, Bedford: the Prize of TEN SOVEREIGNS, for their Set of Patent Apparatus for Cultivating Land by Steam-power. This apparatus is adapted to every variety of soil, and for irregularly-shaped as well as square fields; invented and manufactured by themselves.

STEAM-ENGINES—*Fixed.*

BARRETT, EXALL, AND ANDREWES, Reading, Berks: the Prize of FIFTEEN SOVEREIGNS, for their 10-Horse Power Horizontal Fixed Steam-Engine; invented, improved, and manufactured by themselves.

CLAYTON, SHUTTLEWORTH, AND Co., Lincoln: the Prize of FIFTEEN SOVEREIGNS, for their 10-Horse Power Horizontal Fixed Steam-Engine; improved and manufactured by themselves.

HORNSBY AND SONS, Spittlegate, Grantham, Lincolnshire: the Prize of TEN SOVEREIGNS, for their 10-Horse Power Fixed Steam-Engine; invented, improved, and manufactured by themselves.

JAMES FERRABEE, Brimscombe, near Stroud, Gloucestershire : **HIGHLY COMMENDED** for his 10-Horse Power Horizontal Fixed Steam-Engine ; improved and manufactured by himself.

STEAM-ENGINES—Portable.

HORNSBY AND SONS : the Prize of **TEN SOVEREIGNS**, for their 12-Horse Power Patent Portable Steam-Engine, with Single Cylinder ; invented, improved, and manufactured by themselves.

CLAYTON, SHUTTLEWORTH, AND Co. : the Prize of **SEVEN SOVEREIGNS**, for their 12-Horse Power Patent Double Cylinder Portable Steam-Engine ; improved and manufactured by themselves.

TUXFORD AND SONS, Boston, Lincolnshire : the Prize of **FOUR SOVEREIGNS**, for their 12-Horse Power Patent Portable Steam-Engine, with Two Inverted Vertical Cylinders ; invented and manufactured by themselves.

BARRETT, EXALL, AND ANDREWES : the Prize of **FOUR SOVEREIGNS**, for their 12-Horse Power Double Cylinder Portable Steam-Engine ; invented, improved, and manufactured by themselves.

TUXFORD AND SONS : the Prize of **NINE SOVEREIGNS**, for their 8-Horse Power Patent Portable Steam-Engine, with Inverted Vertical Cylinder ; invented and manufactured by themselves.

BARRETT, EXALL, AND ANDREWES : the Prize of **EIGHT SOVEREIGNS**, for their 8-Horse Power Portable Steam-Engine ; invented, improved, and manufactured by themselves.

CLAYTON, SHUTTLEWORTH, AND Co. : the Prize of **SEVEN SOVEREIGNS**, for their 8-Horse Power Patent Single Cylinder Portable Steam-Engine ; improved and manufactured by themselves.

HOLMES AND SONS, Prospect-place Works, Norwich, Norfolk : the Prize of **ONE SOVEREIGN**, for their Improved 8-Horse Power Portable Steam-Engine ; improved and manufactured by themselves.

BROWN AND MAY, North Wilts Foundry, Devizes, Wilts : **HIGHLY COMMENDED** for their 8-Horse Power Portable Steam-Engine ; manufactured by themselves.

BROWN AND MAY : **COMMENDED** for their 10-Horse Power Portable Steam-Engine ; manufactured by themselves.

JAMES HAYWOOD, JUN., Phoenix Foundry, Derby : **COMMENDED** for his 8-Horse Power Portable Steam-Engine, with Horizontal Cylinder ; invented and manufactured by himself.

ELLIS AND SONS, Oswestry, Shropshire : **COMMENDED** for their 7-Horse Power Portable Steam-Engine ; invented, improved, and manufactured by themselves.

GEORGE PARSONS, Parrett Works, Martock, Somersetshire : **COMMENDED** for his 8-Horse Power Portable Steam-Engine ; improved and manufactured by himself.

HAND-DRESSING MACHINES.

JOSHUA COOCH, Harleston, near Northampton : the Prize of **FIFTEEN SOVEREIGNS**, for his Patent Corn-dressing Machine ; invented, improved, and manufactured by himself.

WILLIAM SAWNEY, Beverley, Yorkshire : the Prize of **TEN SHILLINGS**, for his Combined Corn-dressing, Blowing, and Screening Machine ; invented and manufactured by himself.

- HORNSBY AND SONS**: the Prize of **FIVE SOVEREIGNS**, for their Patent Corn-dressing Machine; invented, improved, and manufactured by themselves.
- JOHN PENNY AND Co.**, City Iron and Wire Works, Broadgate, Lincoln: the Prize of **SIX SOVEREIGNS**, for their Patent Corn Screen; invented, improved, and manufactured by themselves.
- ROBERT BOBY**, St. Andrew's Works, Bury St. Edmunds, Suffolk: the Prize of **FOUR SOVEREIGNS**, for his Improved Patent Corn-screening Machine (No. 1 R); invented, improved, and manufactured by himself.

FINISHING MACHINES.

- HORNSBY AND SONS**: the Prize of **TWENTY-FIVE SOVEREIGNS**, for their Improved Patent Portable Combined Thrashing, Shaking, and Finishing Dressing Machine, for Preparing Corn for Market; invented, improved, and manufactured by themselves.
- CLAYTON, SHUTTLEWORTH, AND Co.**: the Prize of **FIFTEEN SOVEREIGNS**, for their Combined Portable Treble-Blast Finishing Thrashing Machine; invented, improved, and manufactured by themselves.
- WALLIS, HASLAM, AND STEEVENS**, Basingstoke, Hants: the Prize of **TEN SOVEREIGNS**, for their Portable Combined Treble-Blast Finishing Thrashing Machine; invented, improved, and manufactured by themselves.
- HORNSBY AND SONS**: the Prize of **TWENTY SOVEREIGNS**, for their Improved Patent Fixture Combined Thrashing, Shaking, and Finishing Dressing Machine, for Preparing Corn for Market; invented, improved, and manufactured by themselves.
- HOLMES AND SONS**: a **SILVER MEDAL** for their method of Bagging Chaff in a Portable Combined Thrashing Machine.
- ROBEY AND Co.**, Engineers, Lincoln: **COMMENDED** for their No. 1 Portable Combined Double-Blast Thrashing, Shaking, and Dressing Machine, 4 feet 6 inches wide, for Finishing the Corn for Market; invented, improved, and manufactured by themselves.
- HOLMES AND SONS**: **COMMENDED** for their Portable Combined Steam-Thrashing and Finishing Machine; invented, improved, and manufactured by themselves.

BARLEY HUMMELLERS.

- BARRETT, EXALL, AND ANDREWES**: the Prize of **THREE SOVEREIGNS**, for their Barley Horner or Aveller for Horse Power; invented, improved, and manufactured by themselves.
- ROBERT BOBY**: the Prize of **TWO SOVEREIGNS** for his Patent Barley Hummeller or Aveller; invented, improved, and manufactured by himself.

MISCELLANEOUS.

- AMIES AND BARFORD**, Peterborough, Northamptonshire: a **SILVER MEDAL**, for their Patent Wrought-Iron Water Ballasting Land Roller; invented, improved, and manufactured by themselves.
- HERBERT MACKINDER**, Mere Hall, Lincoln: a **SILVER MEDAL**, for his Potato Separator; invented and manufactured by himself.
- EDWARD HUMPHRIES**, Pershore, Worcestershire: a **SILVER MEDAL**, for his Portable Clover Machine; invented, improved, and manufactured by himself.

HORNSBY AND SONS: a **SILVER MEDAL** for their Patent Root Pulper (marked P); invented, improved, and manufactured by themselves.

WALLIS, HASLAM, AND STEEVENS: **COMMENDED** for their Six-row Seed and Manure Drill, with Patent Steerage; invented, improved, and manufactured by themselves.

CLARKE AND SON, Brackley, Northamptonshire: **COMMENDED** for their Adjustable Scythe, for Heavy Crops of grass, corn, &c.; invented and manufactured by themselves.

A. W. GOWER, AND SON, Market Drayton, Shropshire: **COMMENDED** for their Patent Combined Corn Distributor, or Broadcast Sowing and Harrowing Machine; invented by Andrew and Benjamin Gower, of Market Drayton; and manufactured by themselves.

W. S. UNDERHILL, Newport, Salop: **COMMENDED** for his Cheese Press; invented and manufactured by H. Bruckshaw, of Market Drayton.

SEAMAN AND TIPPING, Lowesmoor Iron Works, near Worcester: **COMMENDED** for their Set of 3 Patent Excelsior Steel Plough Whippletrees; invented by Joseph Seaman, and manufactured by themselves.

Essays and Reports.—PRIZES FOR 1864.—All Prizes of the Royal Agricultural Society of England are open to general competition. Competitors will be expected to consider and discuss the heads enumerated.

I. AGRICULTURE OF HERTFORDSHIRE.

FIFTY SOVEREIGNS will be given for the best Report on the Agriculture of Hertfordshire.

The principal geological and physical features of the county should be described; the nature of the Soil and character of the Farming in its different districts; recent changes of Farm Management; Improvements lately introduced and still required; remarkable and characteristic Farms. The various influences exerted by the proximity of London call for special consideration.

II. A SUBURBAN FARM.

A SPECIAL PRIZE OFFERED BY SIR C. DOMVILLE, BART.

TWENTY-FIVE SOVEREIGNS will be given for the best Essay on the Special Description of Farming most suitable for the vicinity of Large Towns, with reference to the requirements of such towns.

Elevations of the buildings best suited for the peculiarities of such management should accompany the Paper.

III. BREAKING-UP PASTURES.

TWENTY SOVEREIGNS will be given for an approved Essay on the best mode of breaking-up Grass, and its subsequent treatment as Arable Land.

IV. CONSTRUCTION OF CHEESE-ROOMS.

TEN SOVEREIGNS will be given for an approved Essay on the Construction of Cheese-rooms.

V. THE PECULIAR QUALITIES OF PASTURES.

TEN SOVEREIGNS will be given for an approved Essay on the Peculiar Qualities which render Pastures especially adapted for the production of Butter and Cheese respectively.

VI. COTTON, LINSEED, AND RAPE CAKE.

TEN SOVEREIGNS will be given for the best Essay on the Comparative Value of Linseed, Rape, and Cotton Cakes for feeding purposes.

VII. STORING ROOTS.

TEN SOVEREIGNS will be given for the best Essay on Storing Turnips, Mangold, Potatoes, and Carrots.

VIII. ANY OTHER AGRICULTURAL SUBJECT.

TEN SOVEREIGNS will be given for an approved Essay on any other Agricultural Subject.

Reports or Essays competing for the Prizes must be sent to the Secretary of the Society, at 12, Hanover Square, London, on or before March 1, 1864. Contributors of Papers are requested to retain Copies of their Communications, as the Society cannot be responsible for their return.

RULES OF COMPETITION FOR PRIZE ESSAYS.

1. All information contained in Prize Essays shall be founded on experience or observation, and not on simple reference to books or other sources. Competitors are requested to use foolscap or large letter paper, and not to write on both sides of the leaf.
2. Drawings, specimens, or models, drawn or constructed to a stated scale, shall accompany writings requiring them.
3. All competitors shall enclose their names and addresses in a sealed cover, on which only their motto, the subject of their Essay, and the number of that subject in the Prize List of the Society, shall be written.*
4. The President or Chairman of the Council for the time being shall open the cover on which the motto designating the Essay to which the Prize has been awarded is written, and shall declare the name of the author.
5. The Chairman of the Journal Committee shall alone be empowered to open the motto-paper of any Essay not obtaining the Prize, that he may think likely to be useful for the Society's objects; with a view of consulting the writer confidentially as to his willingness to place such Essay at the disposal of the Journal Committee.
6. The copyright of all Essays gaining Prizes shall belong to the Society, who shall accordingly have the power to publish the whole or any part of such Essays; and the other Essays will be returned on the application of the writers; but the Society do not make themselves responsible for their loss.
7. The Society are not bound to award a prize unless they consider one of the Essays deserving of it.
8. In all reports of experiments the expenses shall be accurately detailed.
9. The imperial weights and measures only are those by which calculations are to be made.
10. No prize shall be given for any Essay which has been already in print.
11. Prizes may be taken in money or plate, at the option of the successful candidate.
12. All Essays must be addressed to the Secretary, at the house of the Society, on or before the 1st of March, 1864.

* Competitors are requested to write their motto on the enclosed paper on which their names are written, as well as on the outside of the envelope.

Members' Privileges of Chemical Analysis.

THE Council have fixed the following rates of Charge for Analyses to be made by the Consulting Chemist for the *bonâ-fide* use of Members of the Society; who (to avoid all unnecessary correspondence) are particularly requested, when applying to him, to mention the kind of analysis they require, and to quote its number in the subjoined schedule. The charge for analysis, together with the carriage of the specimens, must be paid to him by members at the time of their application.

No. 1.—An opinion of the genuineness of Peruvian guano, bone-dust, or oil-cake (each sample)	5s.
„ 2.—An analysis of guano; showing the proportion of moisture, organic matter, sand, phosphate of lime, alkaline salts, and ammonia	10s.
„ 3.—An estimate of the value (relatively to the average of samples in the market) of sulphate and muriate of ammonia, and of the nitrates of potash and soda	10s.
„ 4.—An analysis of superphosphate of lime for soluble phosphates only	10s.
„ 5.—An analysis of superphosphate of lime, showing the proportions of moisture, organic matter, sand, soluble and insoluble phosphates, sulphate of lime, and ammonia ..	£1.
„ 6.—An analysis (sufficient for the determination of its agricultural value) of any ordinary artificial manure	£1.
„ 7.—Limestone:—the proportion of lime, 7s. 6d.; the proportion of magnesia, 10s.; the proportion of lime and magnesia	15s.
„ 8.—Limestone or marl, including carbonate, phosphate, and sulphate of lime, and magnesia with sand and clay ..	£1.
„ 9.—Partial analysis of a soil, including determinations of clay, sand, organic matter, and carbonate of lime	£1.
„ 10.—Complete analysis of a soil	£3.
„ 11.—An analysis of oil-cake, or other substances used for feeding purposes; showing the proportion of moisture, oil, mineral matter, albuminous matter, and woody fibre; as well as of starch, gum, and sugar, in the aggregate ..	£1.
„ 12.—Analyses of any vegetable product	£1.
„ 13.—Analyses of animal products, refuse substances used for manure, &c.	from 10s. to 30s.
„ 14.—Determination of the “hardness” of a sample of water before and after boiling	10s.
„ 15.—Analysis of water of land drainage, and of water used for irrigation	£2.
„ 16.—Determination of nitric acid in a sample of water	£1.

N.B.—*The above Scale of Charges is not applicable to the case of persons commercially engaged in the Manufacture or Sale of any Substance sent for Analysis.*

The Address of the Consulting Chemist of the Society is, Dr. AUGUSTUS VOELCKER, 101, Leadenhall Street, London, E.C., to which he requests that all letters and parcels (postage and carriage paid) should be directed.

By Order of the Council,

H. HALL DARE, Secretary.

Members' Veterinary Privileges.

I.—SERIOUS OR EXTENSIVE DISEASES.

No. 1. Any Member of the Society who may desire professional attendance and special advice in cases of serious or extensive disease among his cattle, sheep, or pigs, and will address a letter to the Secretary, will, by return of post, receive a reply stating whether it be considered necessary that Professor Simonds, the Society's Veterinary Inspector, should visit the place where the disease prevails.

No. 2. The remuneration of the Inspector will be 2*l.* 2*s.* each day as a professional fee, and 1*l.* 1*s.* each day for personal expenses; and he will also be allowed to charge the cost of travelling to and from the locality where his services may have been required. The fees will be paid by the Society, but the travelling expenses will be a charge against the applicant. This charge may, however, be reduced or remitted altogether at the discretion of the Council, on such step being recommended to them by the Veterinary Committee.

No. 3. The Inspector, on his return from visiting the diseased stock, will report to the Committee, in writing, the results of his observations and proceedings, which Report will be laid before the Council.

No. 4. When contingencies arise to prevent a personal discharge of the duties confided to the Inspector, he may, subject to the approval of the Committee, name some competent professional person to act in his stead, who shall receive the same rates of remuneration.

II.—ORDINARY OR OTHER CASES OF DISEASE.

Members may obtain the attendance of the Veterinary Inspector on any case of disease by paying the cost of his visit, which will be at the following rate, viz., 2*l.* 2*s.* per diem, and travelling expenses.

III.—CONSULTATIONS WITHOUT VISIT.

Personal consultation with Veterinary Inspector	5 <i>s.</i>
Consultation by letter	5 <i>s.</i>
Consultation necessitating the writing of three or more letters.	10 <i>s.</i>
Post-mortem examination, and report thereon	10 <i>s.</i>

A return of the number of applications during each half-year being required from the Veterinary Inspector.

IV.—ADMISSION OF DISEASED ANIMALS TO THE VETERINARY COLLEGE; INVESTIGATIONS, LECTURES, AND REPORTS.

No. 1. All Members of the Society have the privilege of sending cattle, sheep, and pigs to the Infirmary of the Royal Veterinary College, on the same terms as if they were Members of the College; viz., by paying for the keep and treatment of cattle 10*s.* 6*d.* per week each animal, and for sheep and pigs "a small proportionate charge to be fixed by the Principal according to circumstances."

No. 2. The College has also undertaken to investigate such particular classes of disease, or special subjects connected with the application of the Veterinary art to cattle, sheep, and pigs, as may be directed by the Council.

No. 3. In addition to the increased number of lectures now given by Professor Simonds—the Lecturer on Cattle Pathology—to the pupils in the Royal Veterinary College, he will also deliver such lectures before the Members of the Society, at their house in Hanover Square, as the Council shall decide.

No. 4. The Royal Veterinary College will from time to time furnish to the Council a detailed Report of the cases of cattle, sheep, and pigs treated in the Infirmary.

